Sylvia Murphy

Scientific Visualization using NCL

SLP 1963, January 24th
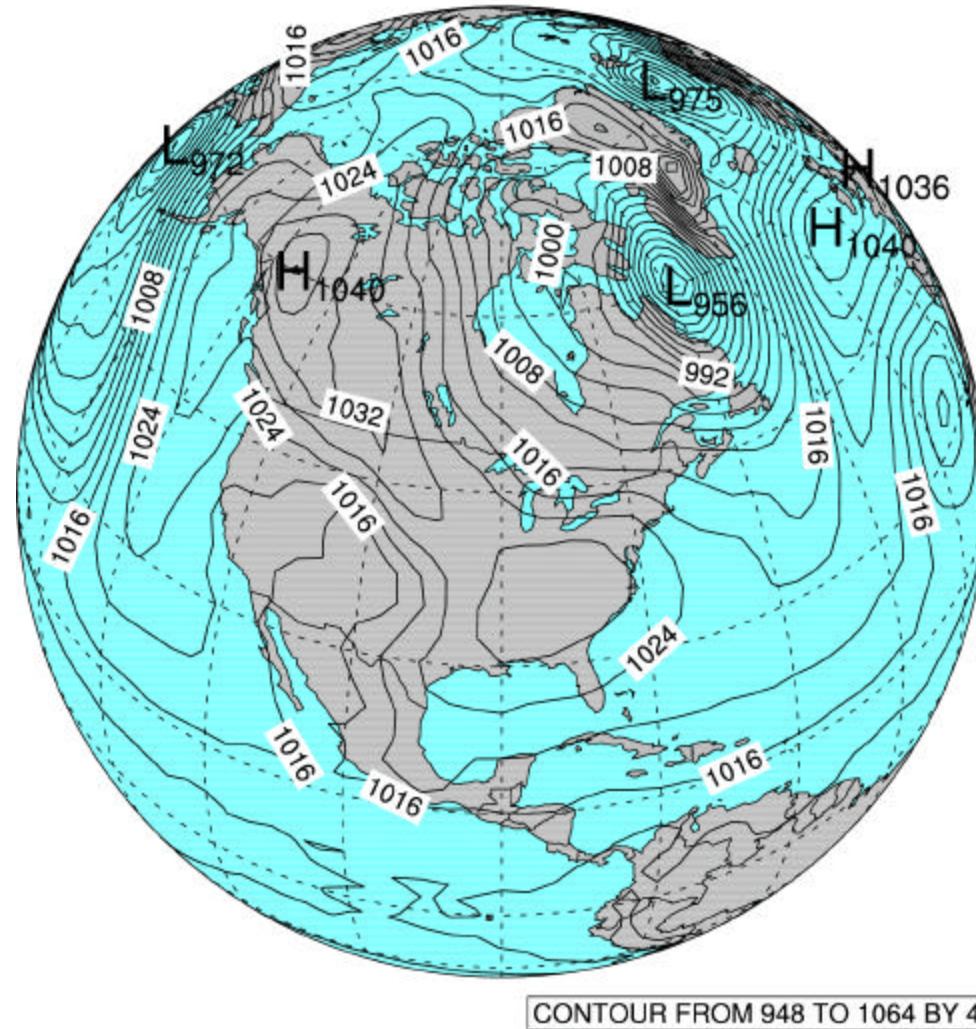
CONTOUR FROM 948 TO 1064 BY 4

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Outline

- How NCL Graphics Works
- Survey of what's possible
- A look at some techniques
- Common error messages
- References
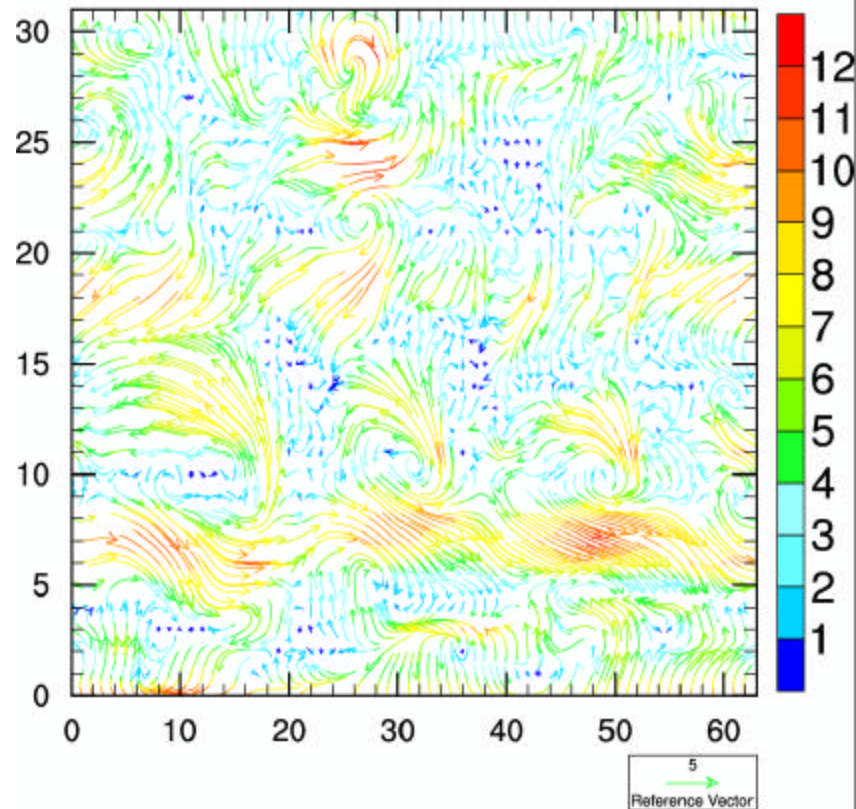
How NCL graphics work

- Object oriented.
  - Tickmarks
  - Contours
  - Labels
  - Map

- Plot interfaces make it easy

- Interfaces are like subroutines/functions

3 types of plot interfaces

- gsn generic
  - simple
  - no extra labeling
- gsn special
  - paneling
  - polylines
- gsn_csm
  - do more for you
  - maps use coordinate variables
  - labels use attributes

NCAR Command Language

Basic Vector Plot

Generic Interfaces

gsn_contour

gsn_streamline

gsn_vector

gsn_vector_scalar

gsn_y

gsn_xy

- **Creates simple default plots.**
- **User may add additional features.**

http://www.cgd.ucar.edu/nclapps/gsn

NCAR Command Language
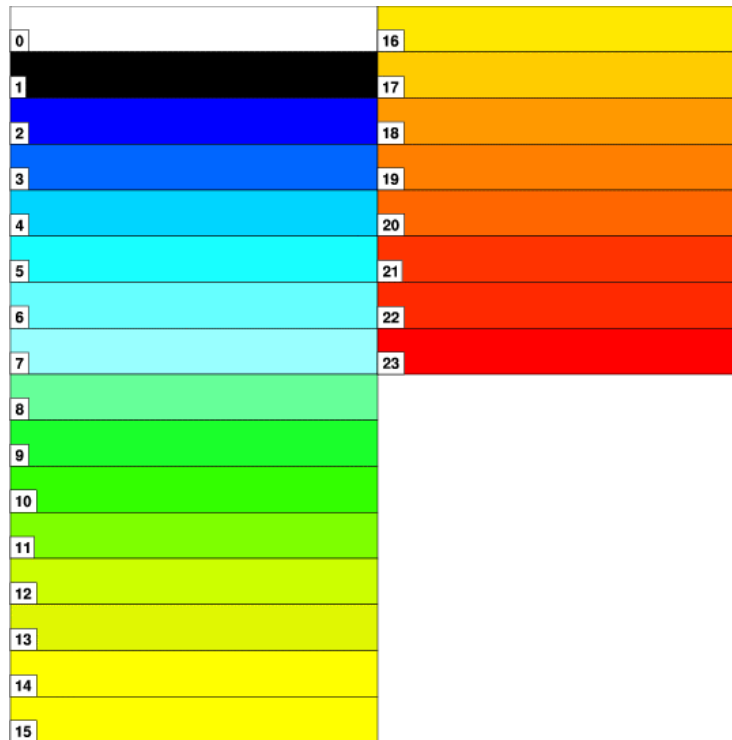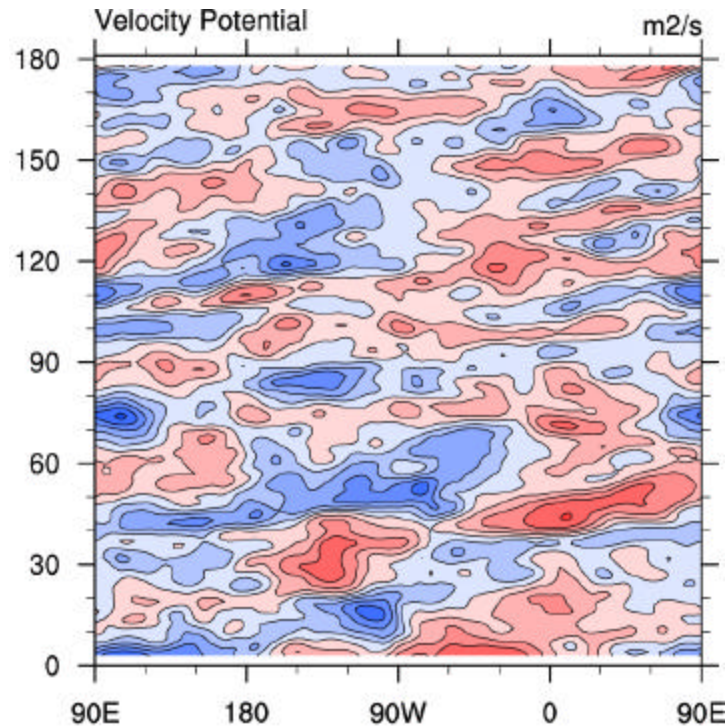

Special Interfaces

gsn_histogram

gsn_draw_colormap

gsn_panel

gsn_add_polyline

gsn_text_ndc

- **Include primitive functions that add polylines, polygons, or text to existing plots.**
- **Perform special functions like merging color maps, or paneling a group of plots.**

http://ngwww.ucar.edu/ngdoc/ng/ug/ncl/gsun

NCAR Command Language

gsn_csm interfaces
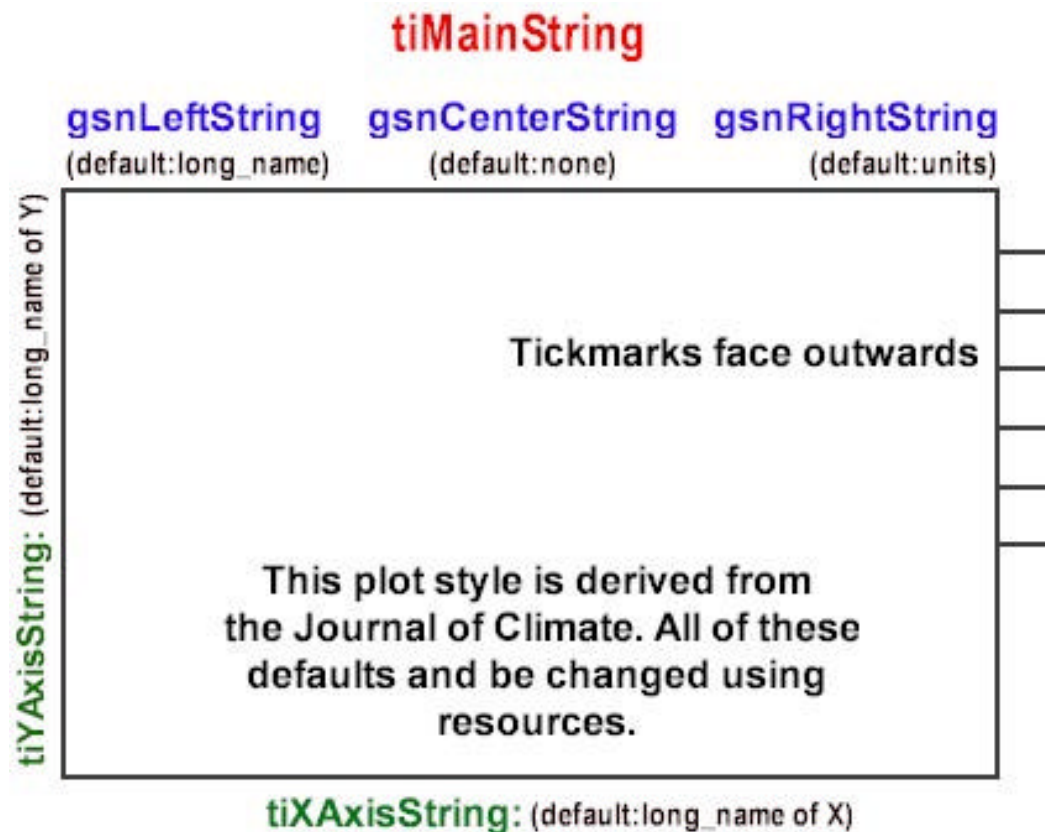
gsn_csm_contour

gsn_csm_map

gsn_csm_contour_map_ce

gsn_csm_streamline_polar

gsn_csm_vector

- Creates more complex plots

- Do a lot of things for you automatically

- Follow a particular style

http://www.cgd.ucar.edu/csm/support/CSM_Graphics

gsn_csm style

gsn_csm does things for you.

- **long_name and units attribute plotted as labels**
- **uses coordinate variables when creating a map**
- **Automatic label bar**
- **Gray continents for B&W plots**
- **Adjusts positions of multiple labels**
- **"nice" lat/lon labels on cylindrical equidistant and polar stereographic maps. e.g. "30N"**
- **Cyclic point added to data on map plots**

Loading

- plot interfaces are in library scripts
- they must be loaded before the "begin" statement

```
load "$NCARG_ROOT/lib/ncarg/nclscripts/csm/gsn_code.ncl

load "$NCARG_ROOT/lib/ncarg/nclscripts/csm/gsn_csm.ncl

begin

  statements

end
```

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gsn_csm map expectations (1 of 2)

The coordinate variables themselves must have a units attribute (climate and forecast netCDF convention):

degrees_north	degrees_east
degrees-north	degrees-east
degree-north	degree-east
degrees north	degrees east
degrees_N	degrees_E
Degrees_north	Degrees_east

No attribute results in an annoying warning message!!!!

scenario: your units attribute is slightly different and you

want to get rid of that annoying warning message:

- You can rename your attribute:

    data(lat,lon)

    data&lat@units = "degrees_north"

gsn* vs. gsn_csm summary

- The difference confuses many users
- Documentation in two different locations
- 99% of time use gsn_csm

gsn* templates	gsn_csm templates
Don't want *J. Climate* style	Want automatic labeling
	Want automatic label bar
	Data has attributes

Outline

- How NCL Graphics Works

- **Survey of what's possible**

- A look at some techniques

- Common error messages

- References

A quick review of the plot interfaces

Cylindrical Equidistant Templates

gsn_csm_vector_map_ce

gsn_csm_vector_scalar_map_ce

gsn_csm_contour_map_ce

gsn_csm_contour_scalar_map_ce

gsn_csm_streamline_map_ce

gsn_csm_streamline_contour_map_ce

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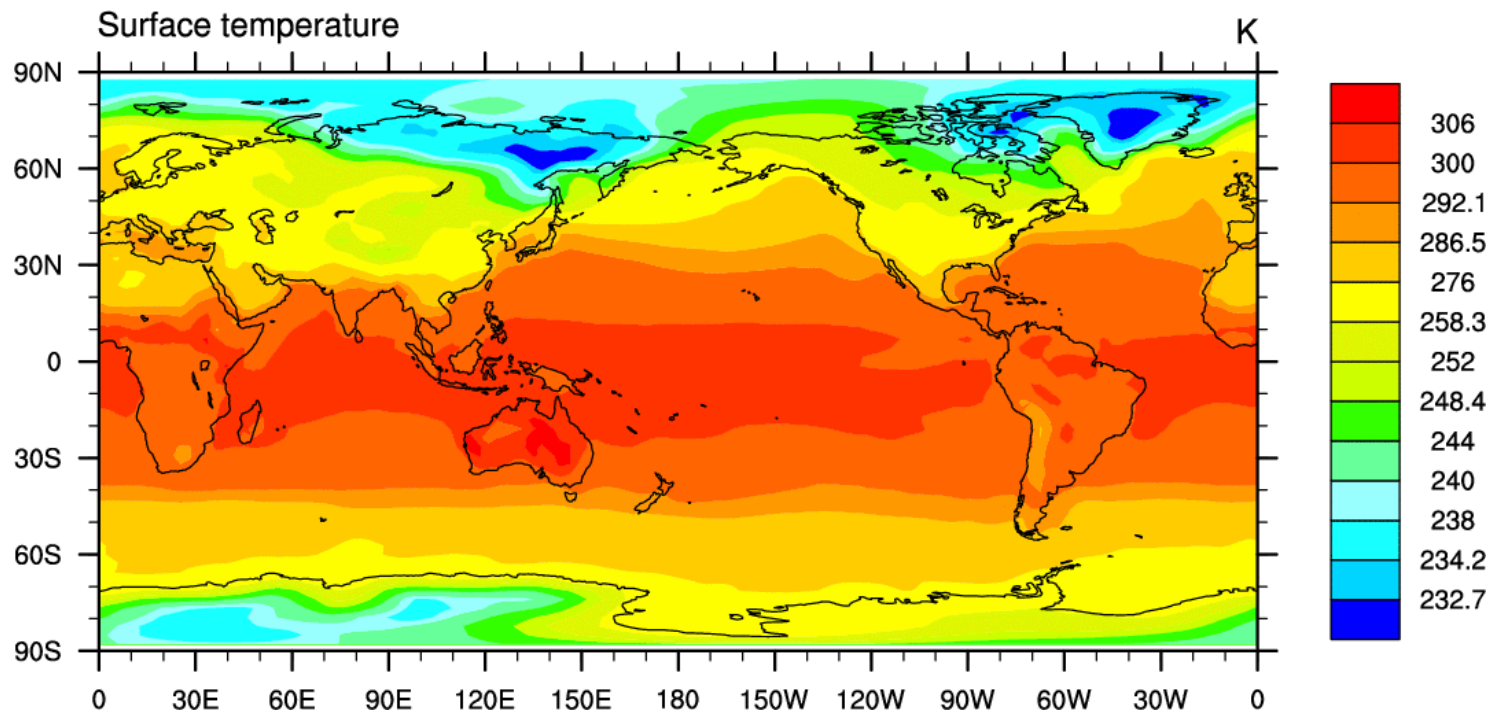
Vector Plot Templates

gsn_csm_vector_map_ce

gsn_csm_vector_scalar_map_ce

gsn_csm_vector_map_polar

gsn_csm_vector_scalar_map_polar

gsn_csm_pres_hgt_vector
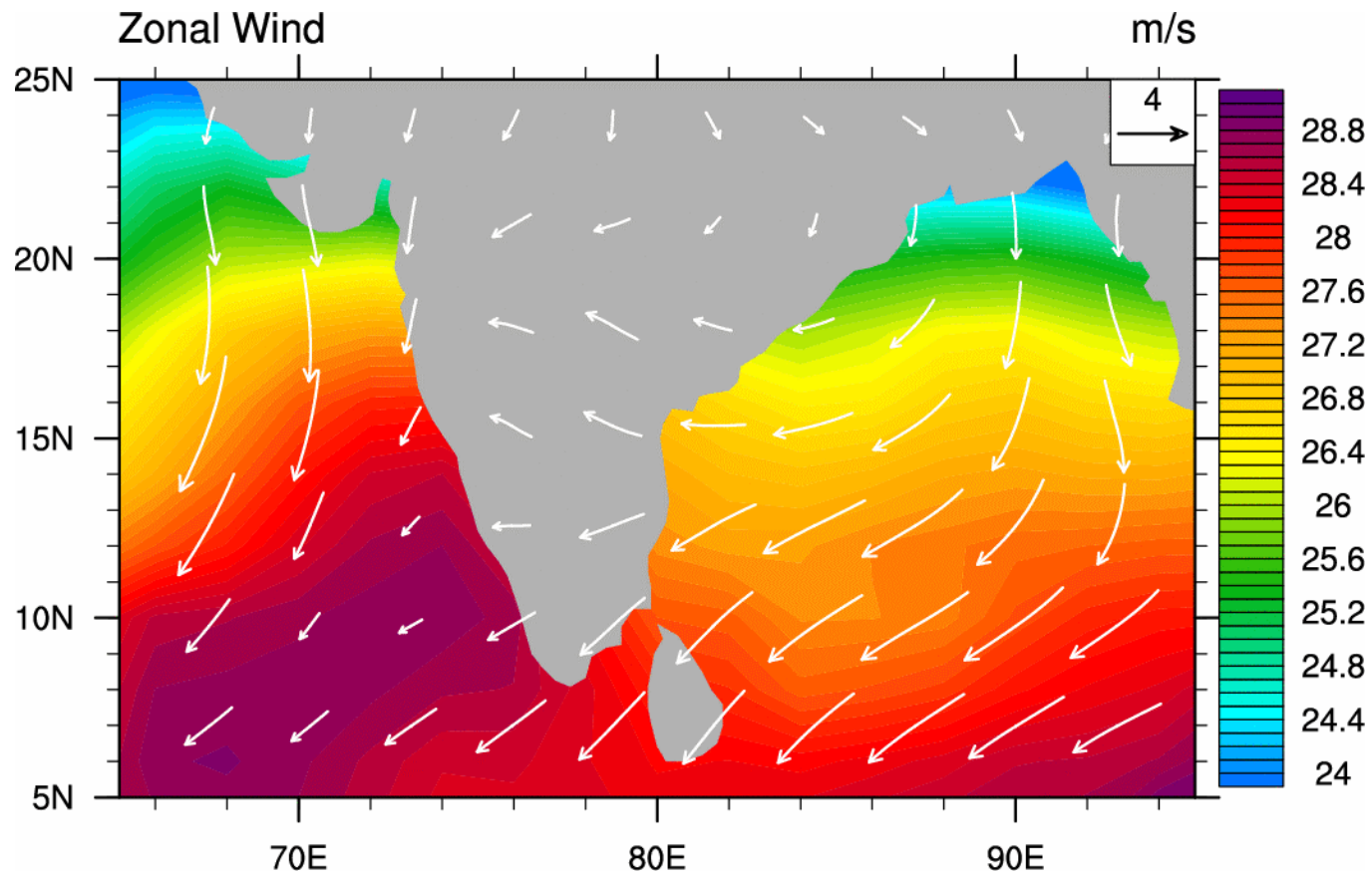
Streamline Templates

gsn_csm_streamline_map_ce

gsn_csm_streamline_contour_map_ce

gsn_csm_streamline_map_polar

gsn_csm_streamline_contour_map_polar

gsn_csm_pres_hgt_streamline

Zonal Wind — m/s

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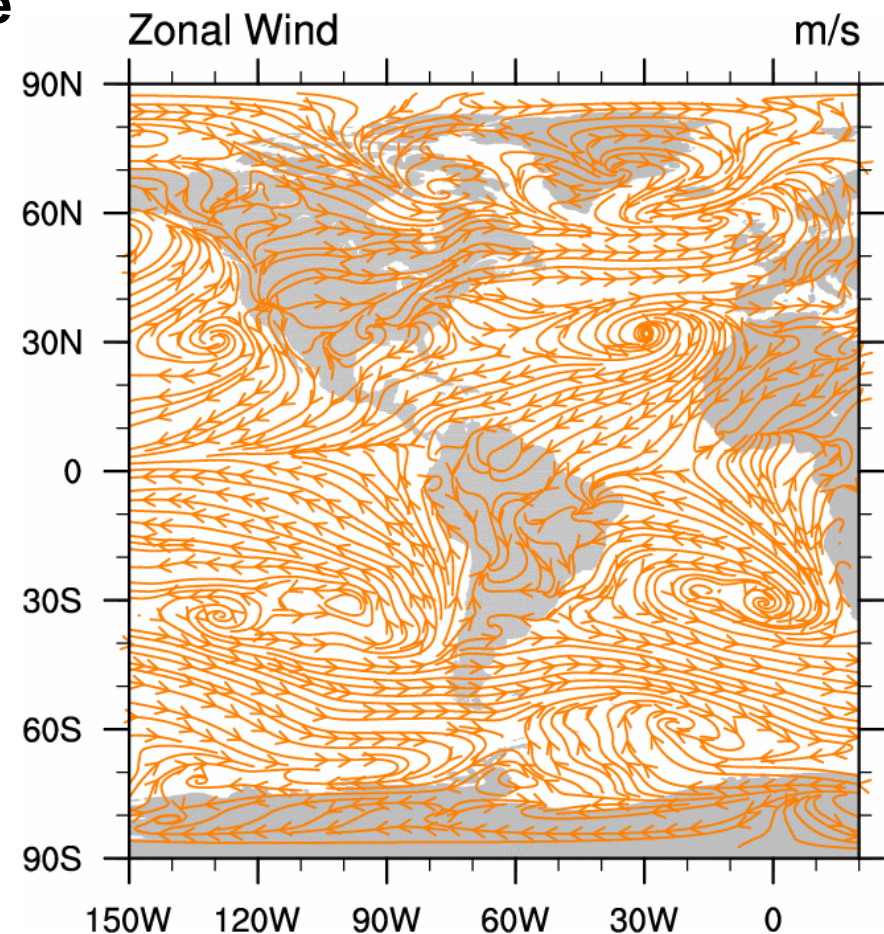
Polar Stereographic Templates

gsn_csm_vector_map_polar

gsn_csm_vector_scalar_map_polar

gsn_csm_contour_map_polar

gsn_csm_streamline_map_polar
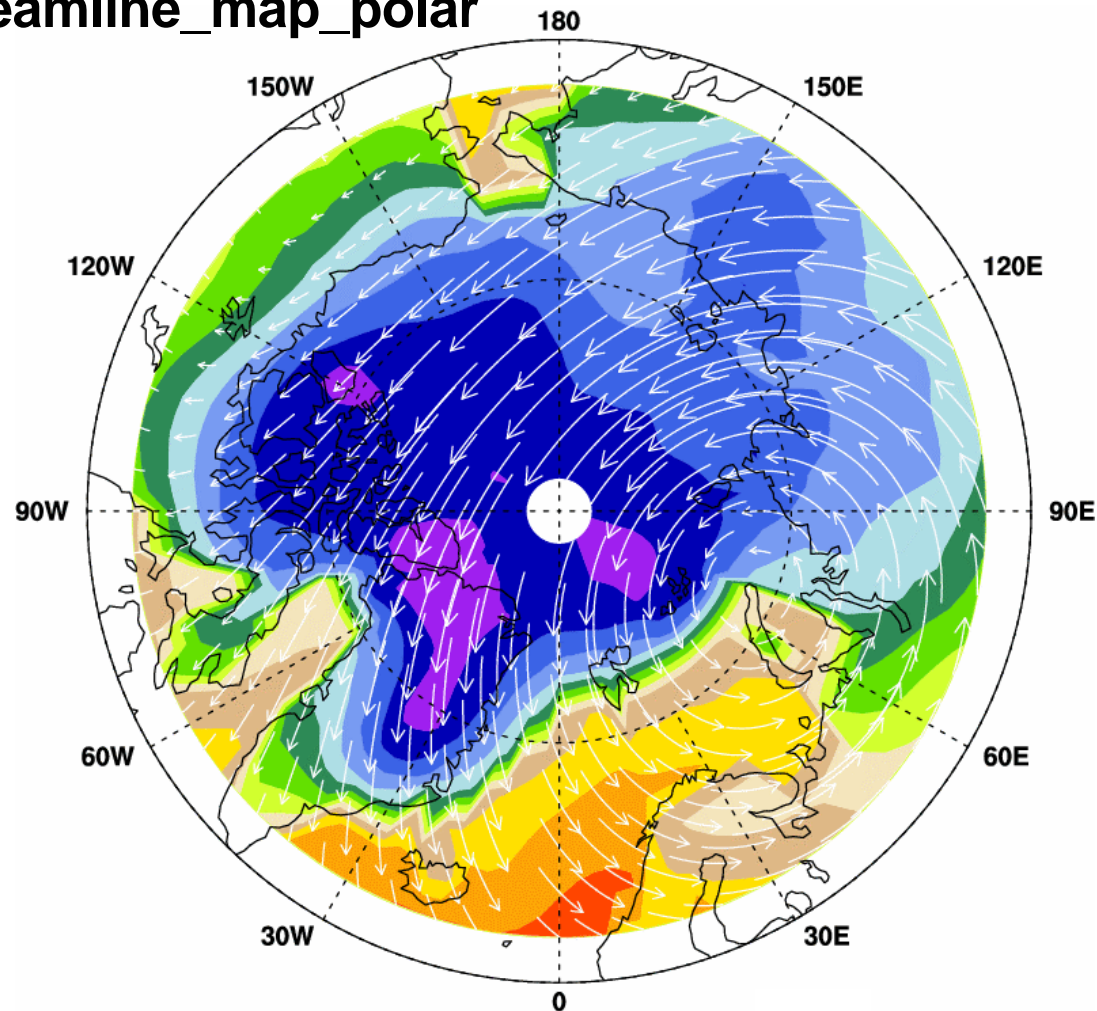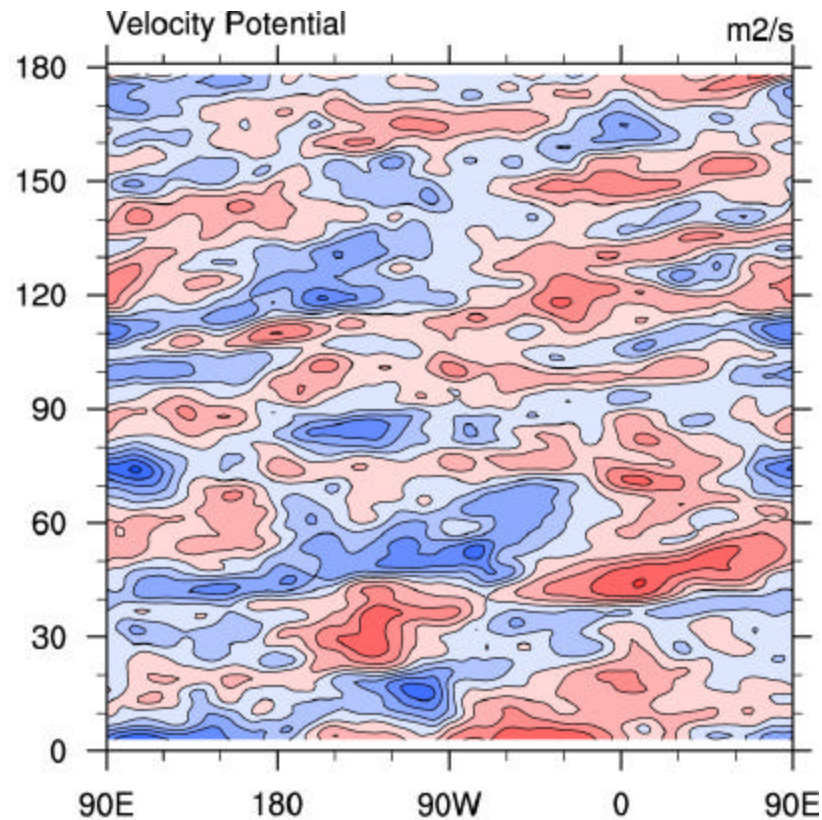
Templates with time axis
(1 of 2)

gsn_csm_hov

gsn_csm_time_lat
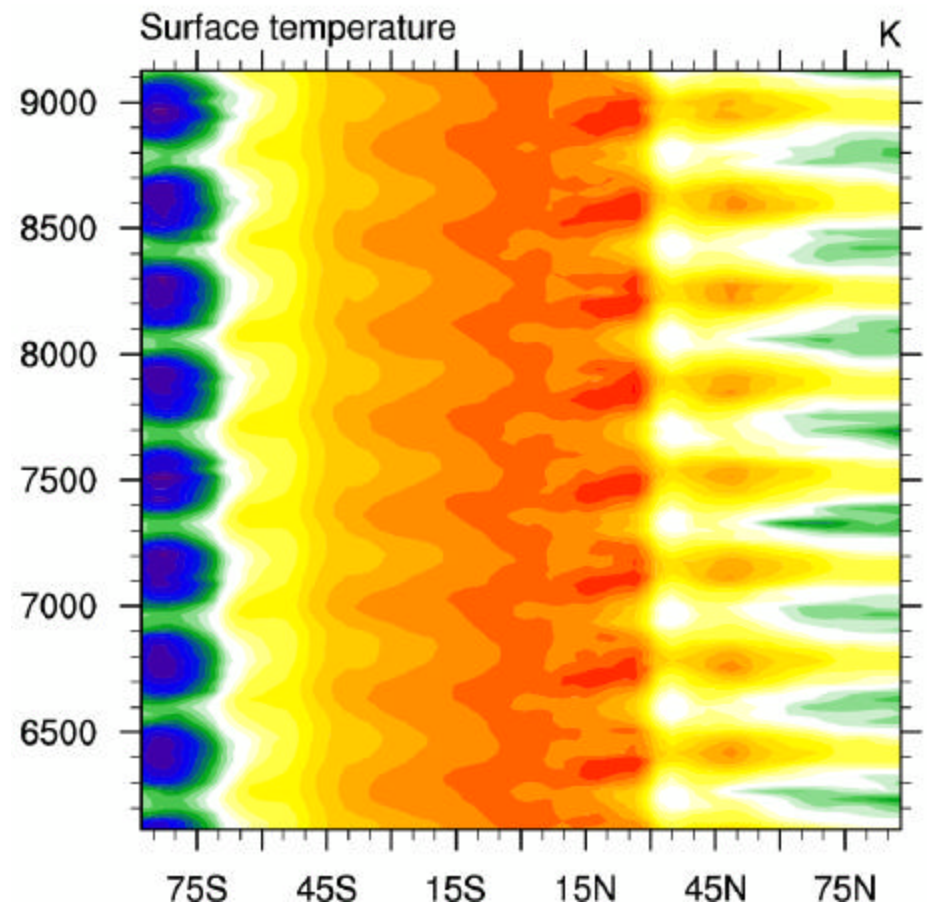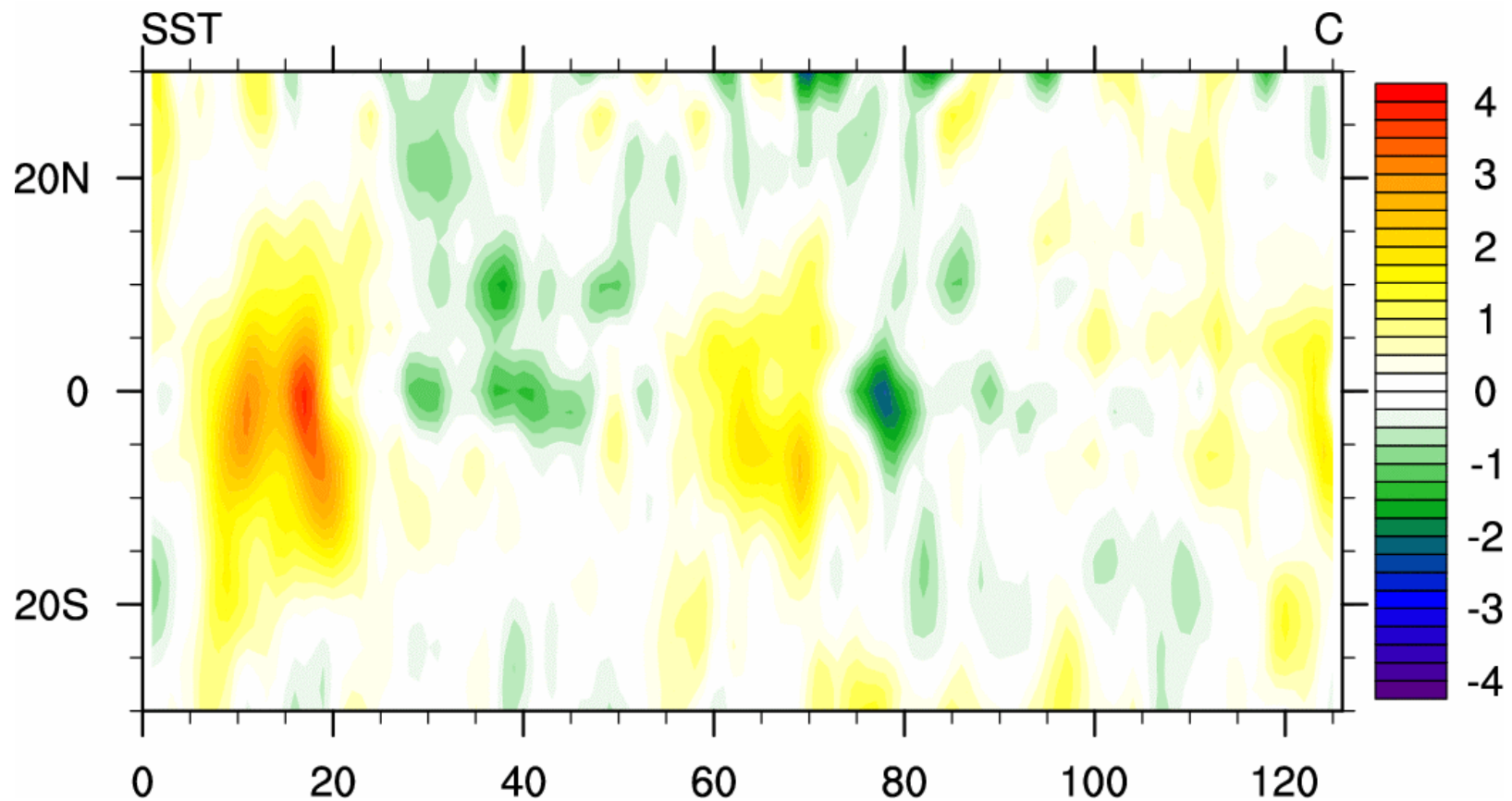
gsn_csm_lat_time

Pressure Height

gsn_csm_pres_hgt_vector
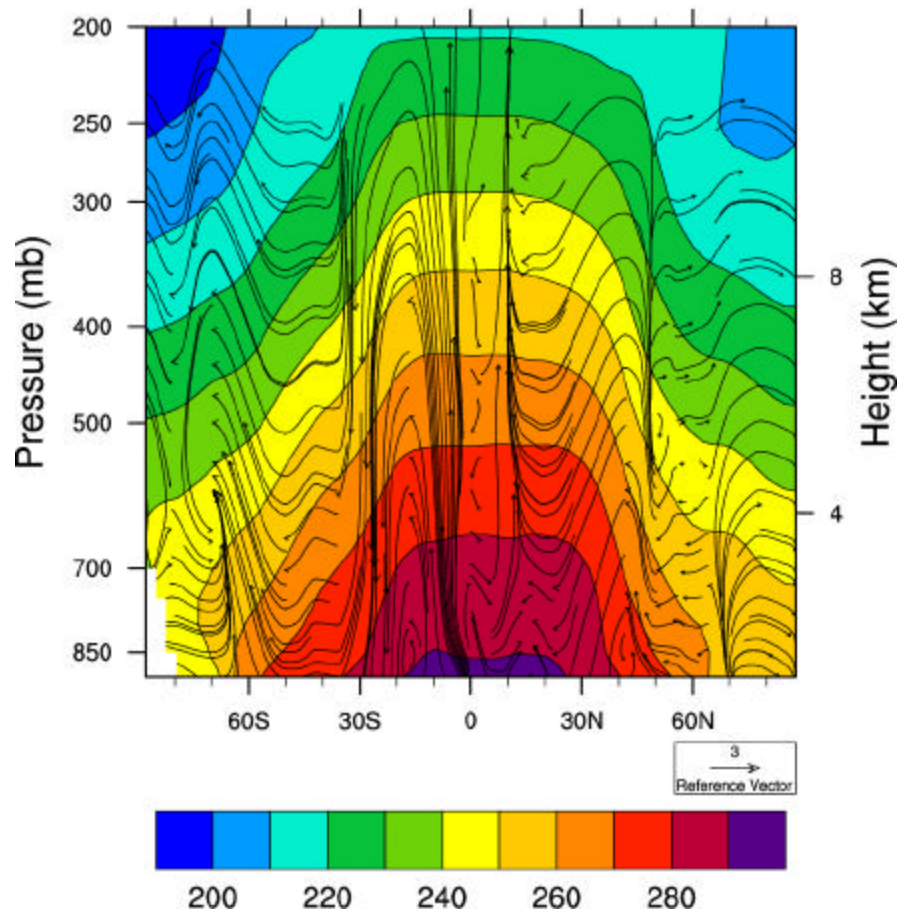
gsn_csm_pres_hgt
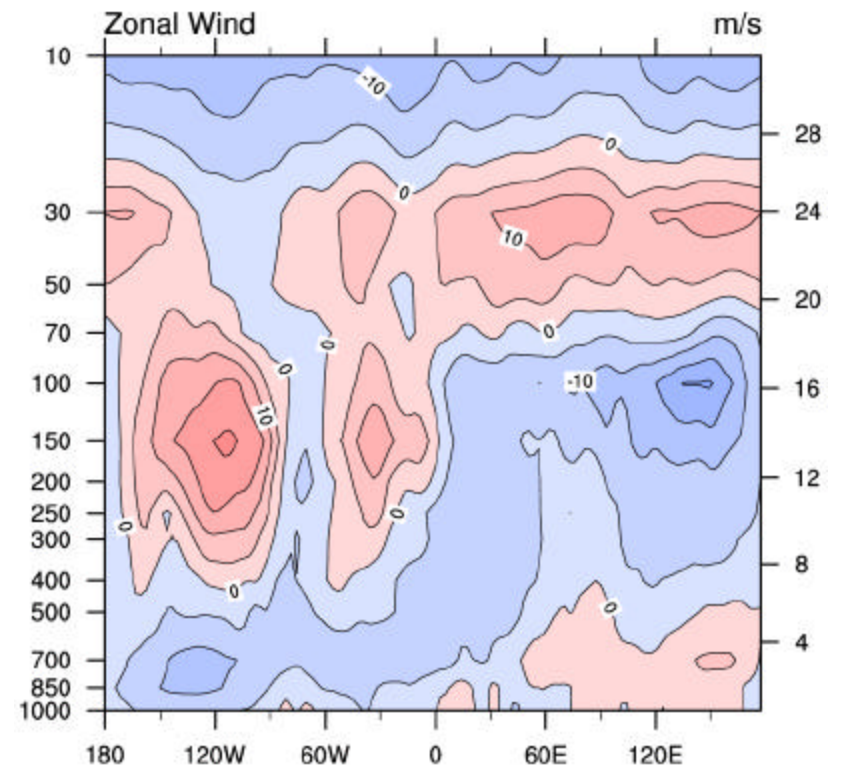
Line Type Templates
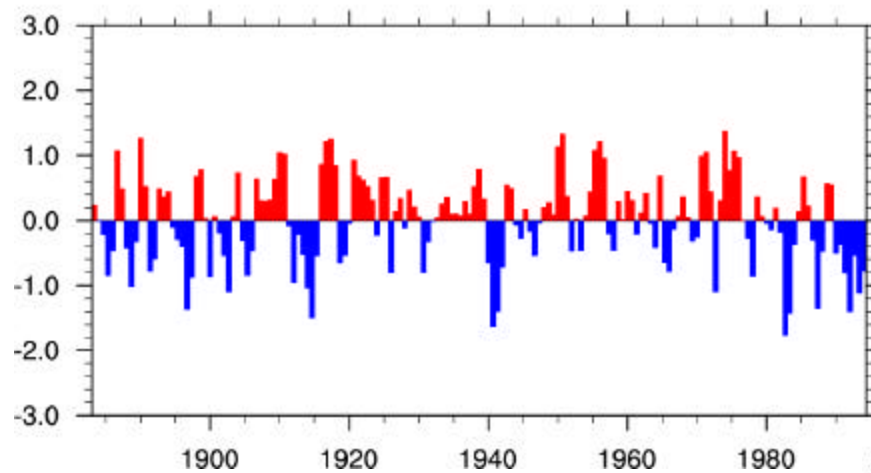
gsnXYBarChart = True

gsn_csm_xy

gsn_csm_y

plot_xy2

gsn_polyline

gsn_add_polyline

σ

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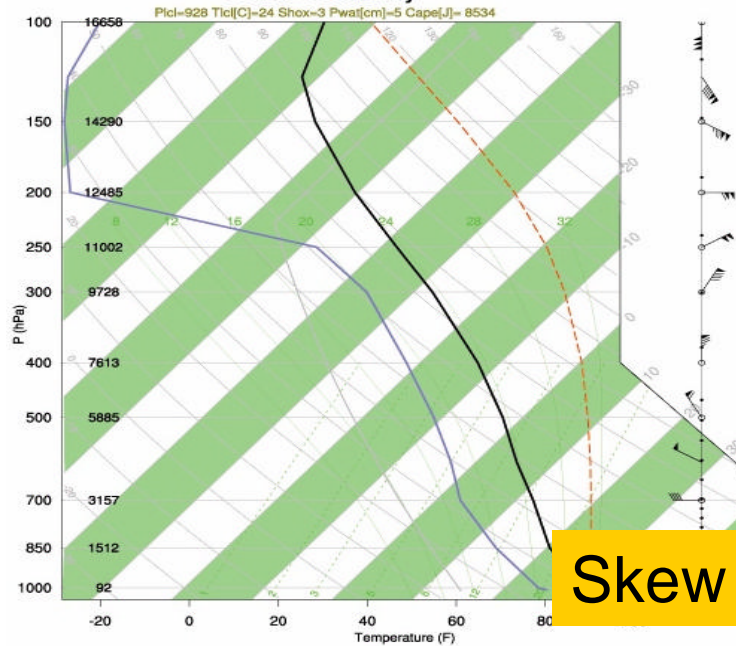# NCAR Command Language
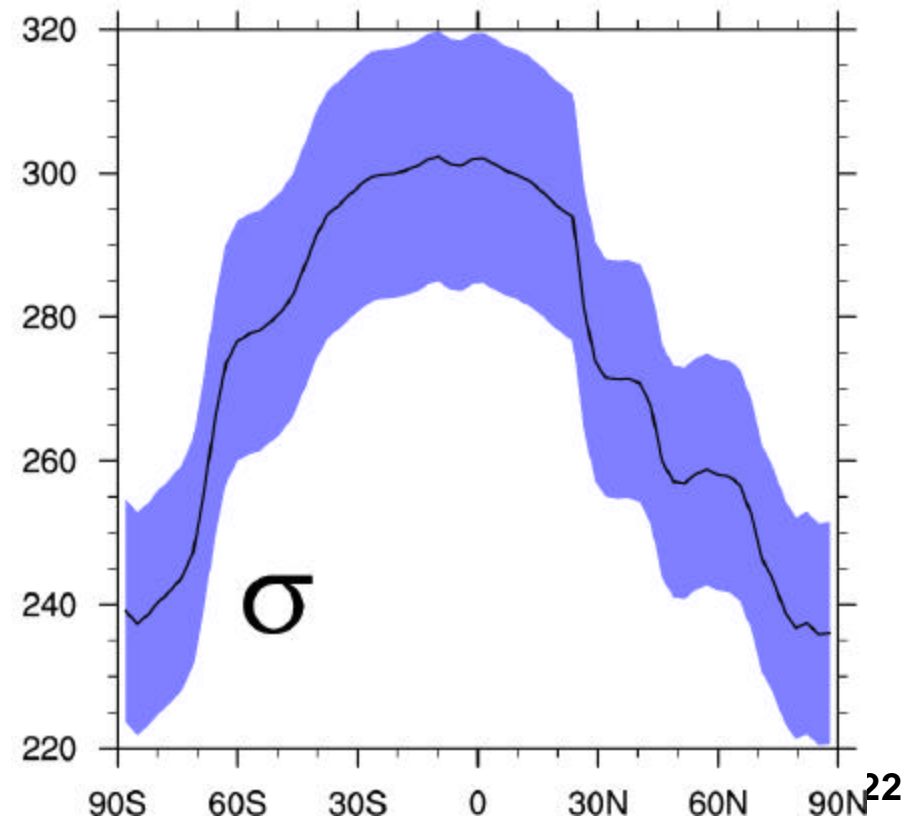
Special Templates and Scripts

Polygons

Wind Rose: Color + Variable Thickness
SpdAve=21 SpdStd=13 DirAve=257 Calm= 0.5%
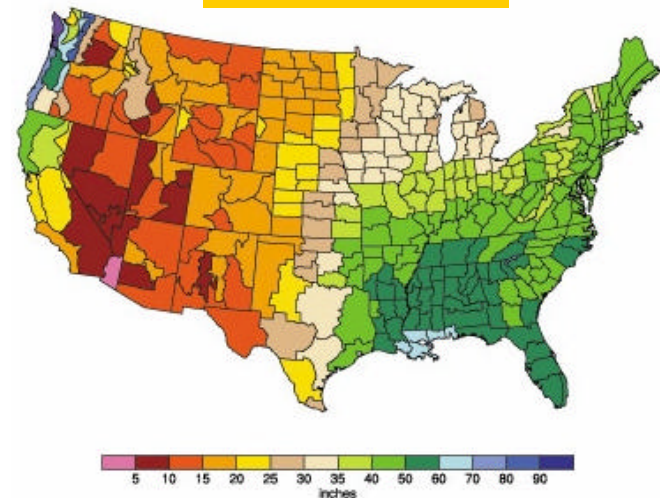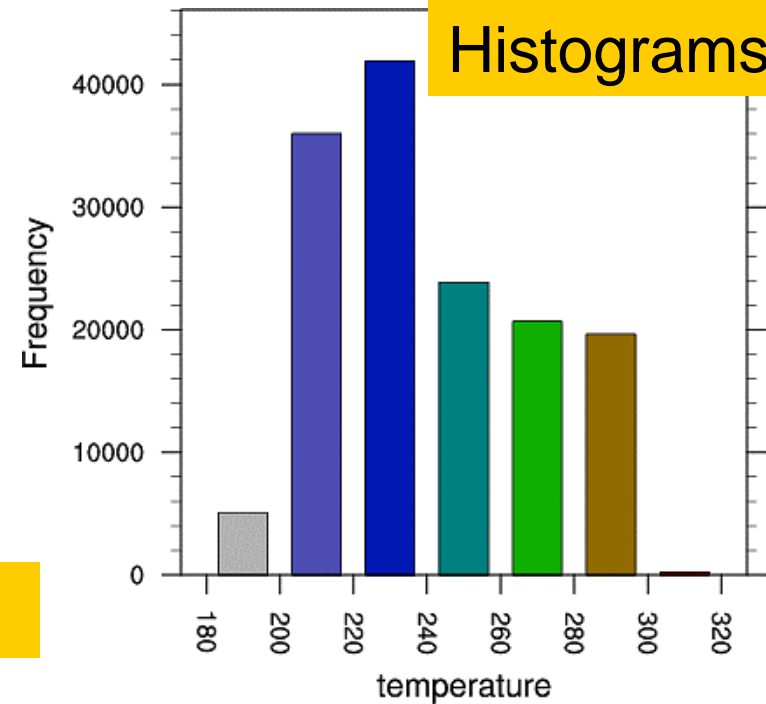Frequency circles every 10%. Mean speed indicated.

Wind Rose

Histograms

Raob Data only
Plcl=928 Tlcl[C]=24 Shox=3 Pwat[cm]=5 Cape[J]= 8534

Skew T

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OUTLINE

- # A look at some techniques
  - Where does the plot go
  - How to modify the plot
  - .hluresfile
  - function codes
  - color
  - vectors
  - contours
  - tickmarks
  - coastlines
  - resizing
  - paneling
  - adding text
  - powerpoint

Graphic Workstation

- Location where graphical instructions sent.

- May have multiple workstations open.

- Opened with the following command:

  wks = gsn_open_wks ("type", "title")

- Types include:
  postscript: "ps", "eps", and "epsi"
  meta file: "ncgm"
  window: "X11"
  pdf: "pdf"   (version 4.2.0.a028)

eps : contain bounding box

epsi: contains bitmap preview

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Graphical Resources
(1 of 2)

- Resources (options) allow users to alter default plots.

- Passed as attributes of a logical variable (similar to optional arguments in F90/C).

```
res                        = True          ; create logical

res@tiMainString           = "Plot Title"  ; title

res@cnFillOn               = True          ; turn on color

res@cnInfoLabelON          = False         ; turn off info label

plot = gsn_csm_contour_map_ce(wks, T, res)   ; create plot
```

http://www.cgd.ucar.edu/csm/support/CSM_Graphics/resource_index.shtml
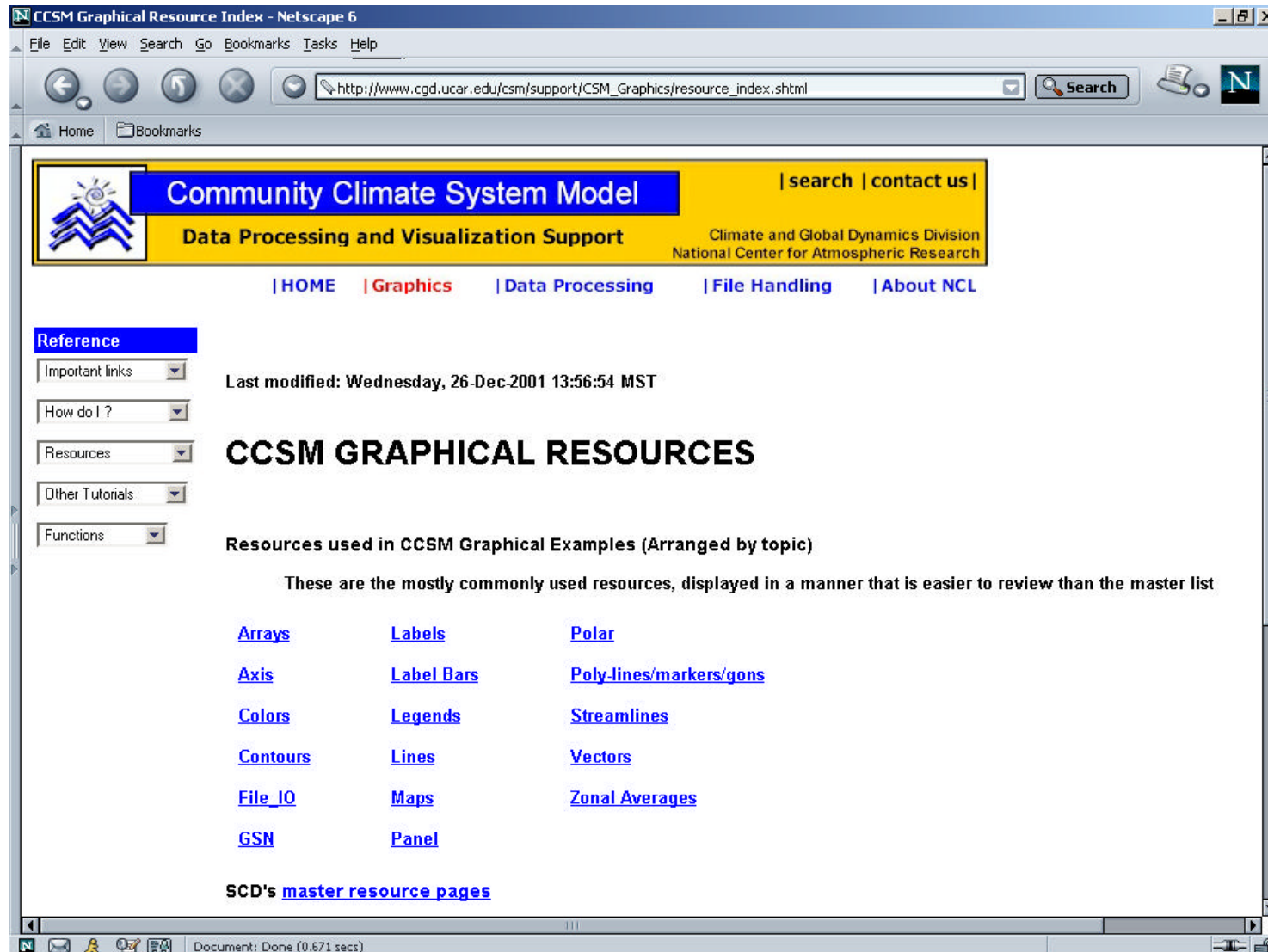
.hluresfile: must have

```
# Color of window

*wkForegroundColor:(/0.,0.,0./)

*wkBackgroundColor:(/1.,1.,1./)

# Common Font

*Font: helvetica

# X11 Window size

*wkWidth: 800

*wkHeight: 800

# Default Text Function Code

*TextFuncCode:~
```

- Controls the user's default NCL graphics environment.

- Put one in the home directory of EVERY computer on which you run NCL.

Text Function Code

- Is an escape sequence to subscript, superscript, or change fonts in the middle of a text string.

- Default is a colon **:**

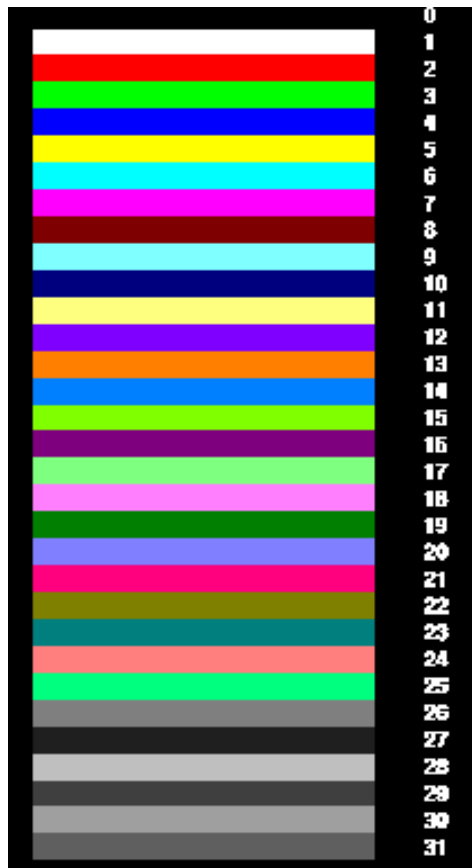- Can be controlled in the script or the .hluresfile

Superscript:	10°**E**
10~S~o~N~E	
Subscript:	H_{k-1}
H:B:k-1	
Greek Character:	**?**
~F33~s	

Colors

Default Color Map

- The moment a workstation is opened, it is associated with the NCL default color map.

- A color map is associated with a workstation, NOT a particular plot.

- To create a color contour fill plot the following must be added to the resources list:

  - **cnFillOn = True**

Changing Colors

- **gsn_define_colormap** (wks, type)
  –built-in colormap (e.g. "gui_default")
  –array of RGB triplets
  –array of named colors

List of Named Colors

http://www.cgd.ucar.edu/csm/support/CSM_Graphics/Scripts/rgb.txt

Built-in Color Tables

http://www.ngwww.ucar.edu/ncl/coltable.html

Color Examples

http://www.cgd.ucar.edu/csm/support/CSM_Graphics/color.shtml

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Using a color map

rainbow+gray
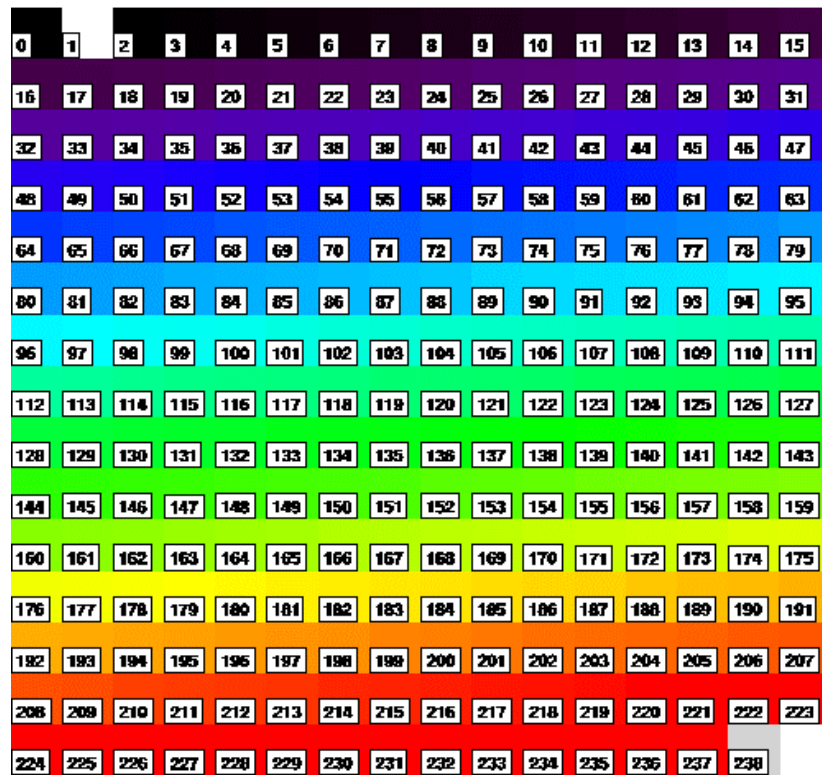
- NCL will use the same number of colors as contour intervals.

- It will choose them in sequential order.

- To use the full colormap:

  gsnSpreadColors = True

- You can select a start and stop point with:

  gsnSpreadColorStart = #
  gsnSpreadColorEnd = #

NCAR Command Language

gsn_csm_vector_map_ce
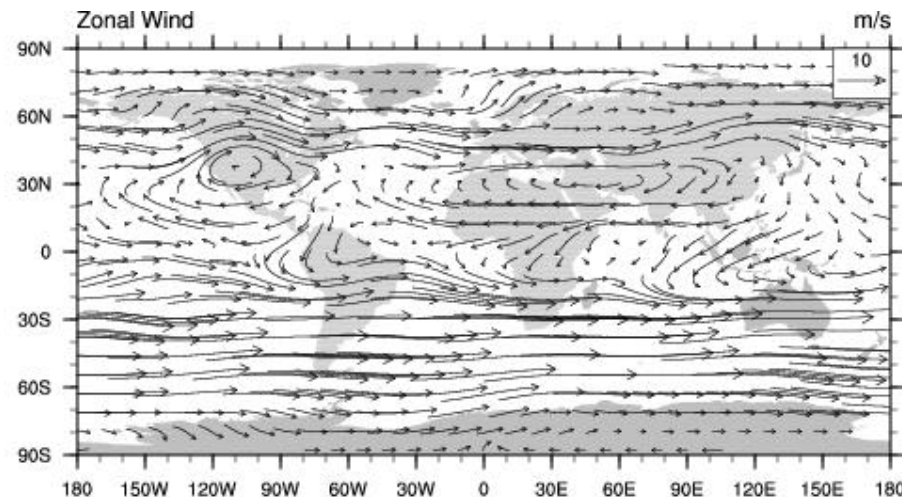
vcres@vcRefMagnitudeF	= 10.0	; define vector ref mag
vcres@vcRefLengthF	= 0.045	; define length of ref vector
vcres@vcGlyphStyle	= "CurlyVector"	; turn on curly vectors
vcres@vcMinDistanceF	= 0.017	; thin vectors

http://www.cgd.ucar.edu/csm/support/CSM_Graphics/vector.shtml

gsn_csm_vector_scalar_map_ce
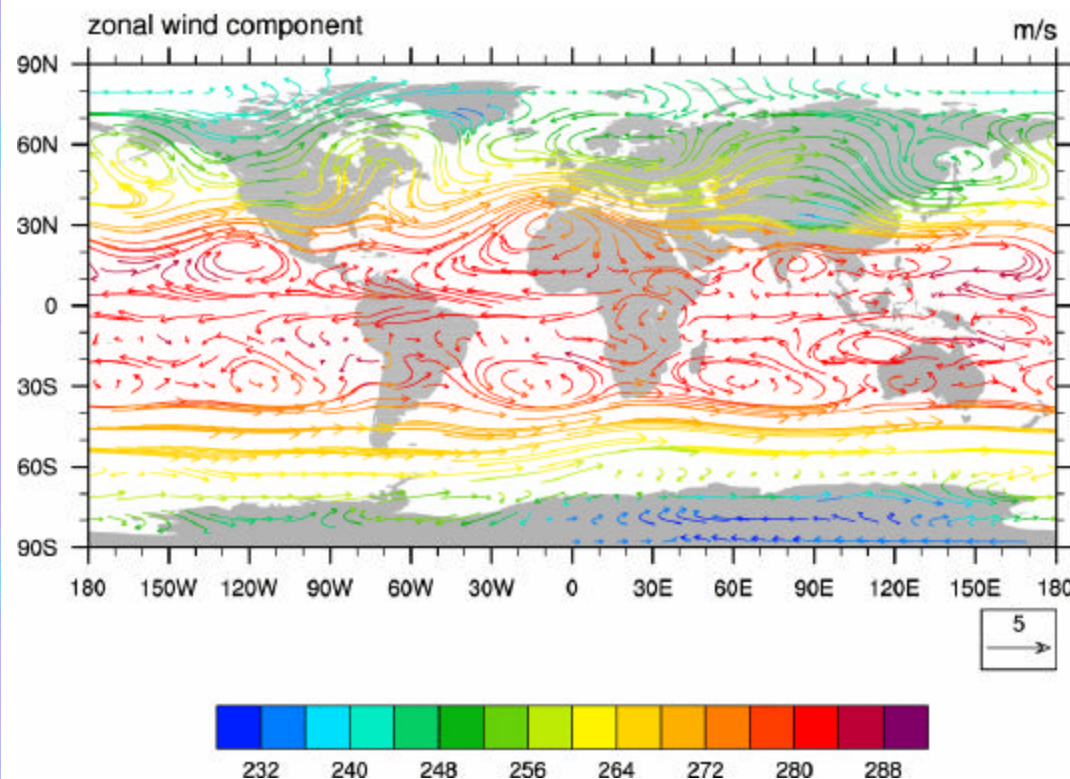
- Default is to color the vectors by a scalar field
- Set **gsnScalarContour = True** to get vectors on top of contours.

NCAR Command Language

gsn_csm_vector_scalar_map_ce

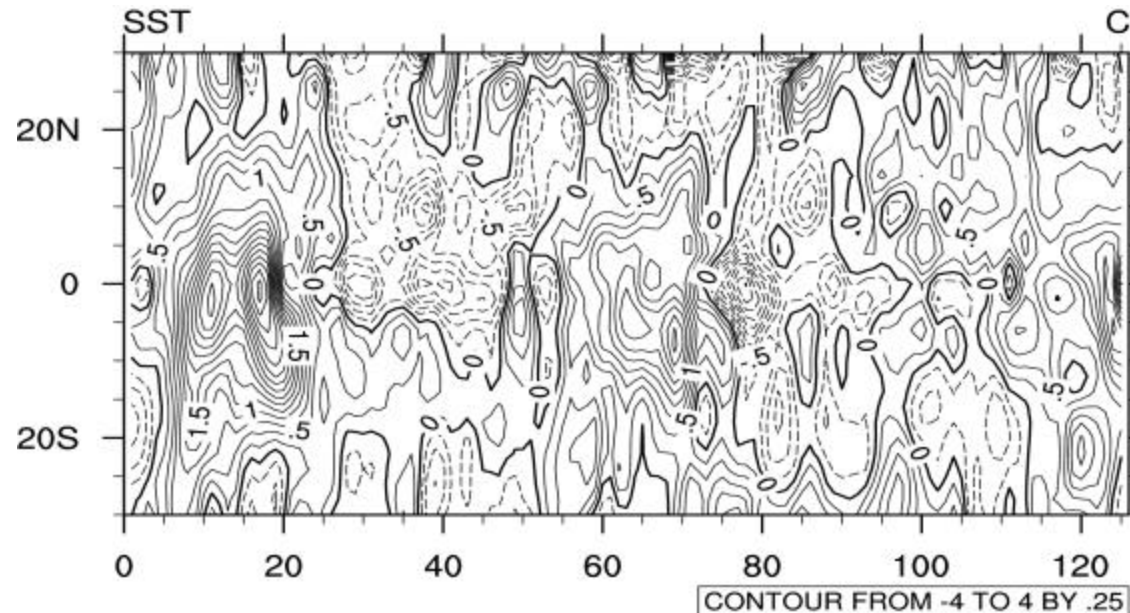**gsnScalarContour = True**

NCAR Command Language
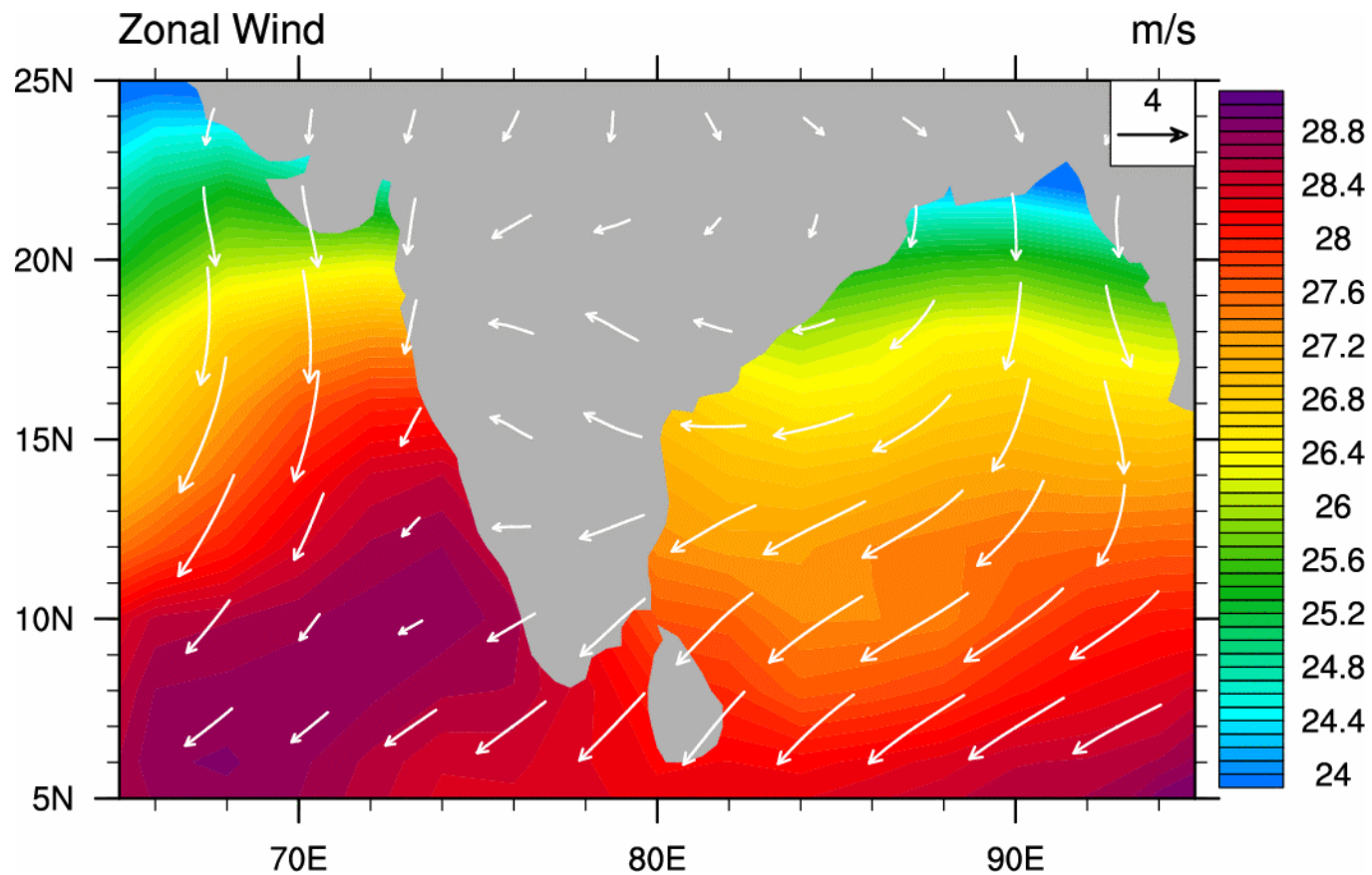
gsn_csm_contour_map_ce
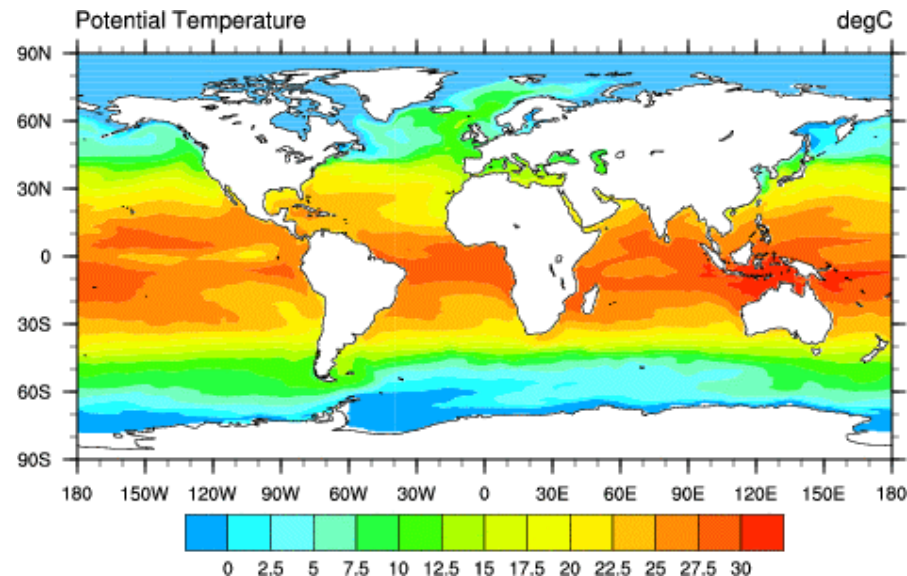
res@cnLevelSelectionMode = "ManualLevels"
res@cnMinLevelValF   = 0
res@cnMaxLevelValF   = 30
res@cnLevelSpacingF   = 2.5

Contour effects from shea_util.ncl


```
load "$NCARG_ROOT/lib/ncarg/nclscripts/csm/shea_util.ncl"
res                = True
res@gsnDraw   = False
res@gsnFrame = False
plot = gsn_csm_lat_time(wks, sdemo({-30:30},:), res)
plot = ZeroNegDashLineContour(plot)
draw (plot)
frame (wks)
```

http://www.cgd.ucar.edu/csm/support/CSM_Graphics/coneff.shtml

Other common contour resources

cnLinesOn   = False   ; turn off contour lines

cnInfoLabelOn = False   ; turn off cn info label

Control the placement of contour labels:

cnLineLabelPlacementMode = "constant"

Explicit Contour Levels:

cnLevelSelectionMode = "ExplicitLevels"

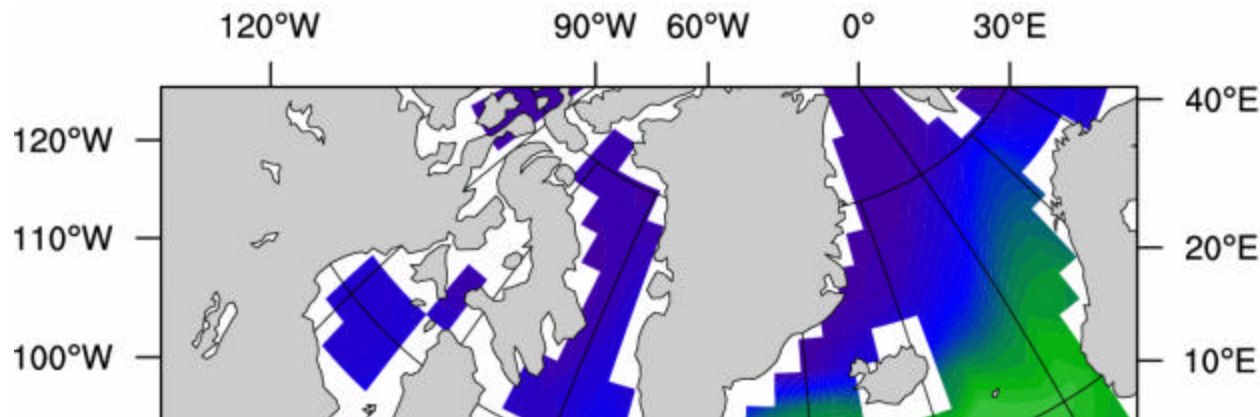cnLevels   = (/0.5,1.0,2.0,3,0,4.0,5.0,7.5,10.0/)

Lat/Lon Labels
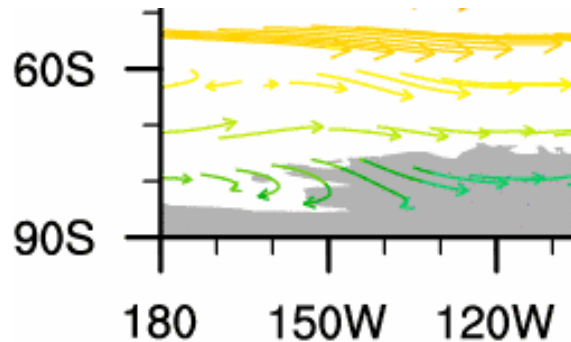
- Plot templates create "nice" labels on cylindrical equidistant and polar stereo graphic projections.

- **tmXBLabelFontHeightF** controls

res@pmTickMarkDisplayMode = "Always"

- Turns on default NCL tickmarks.
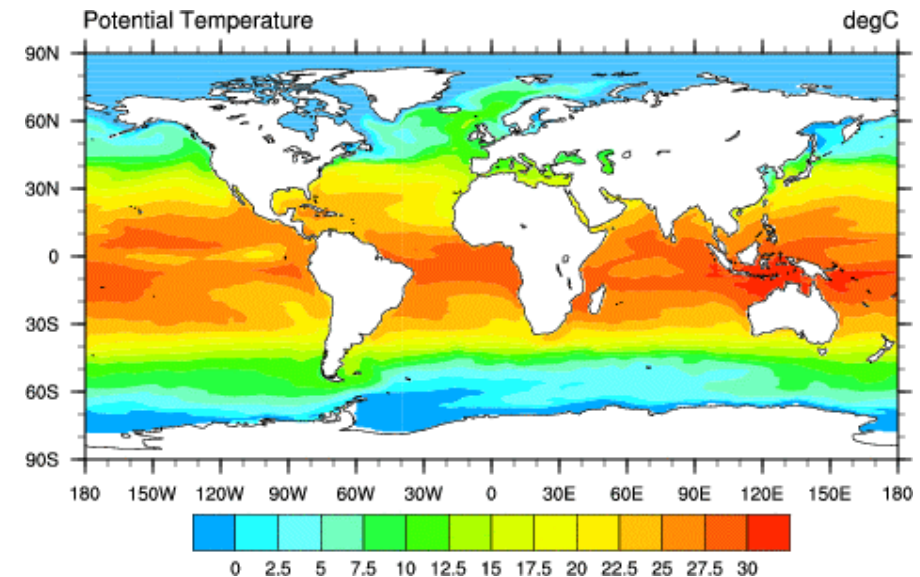
- Version 4.2.0.a023 or later

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NCAR Command Language

```
time = 1
nlat  = 345
nlon = 567

float TLONG (nlat,nlon)
float TLAT (nlat,nlon)
float ROFF (time,nlat,nlon)
```


Potential Temperature   degC

lat2d   = f->TLAT
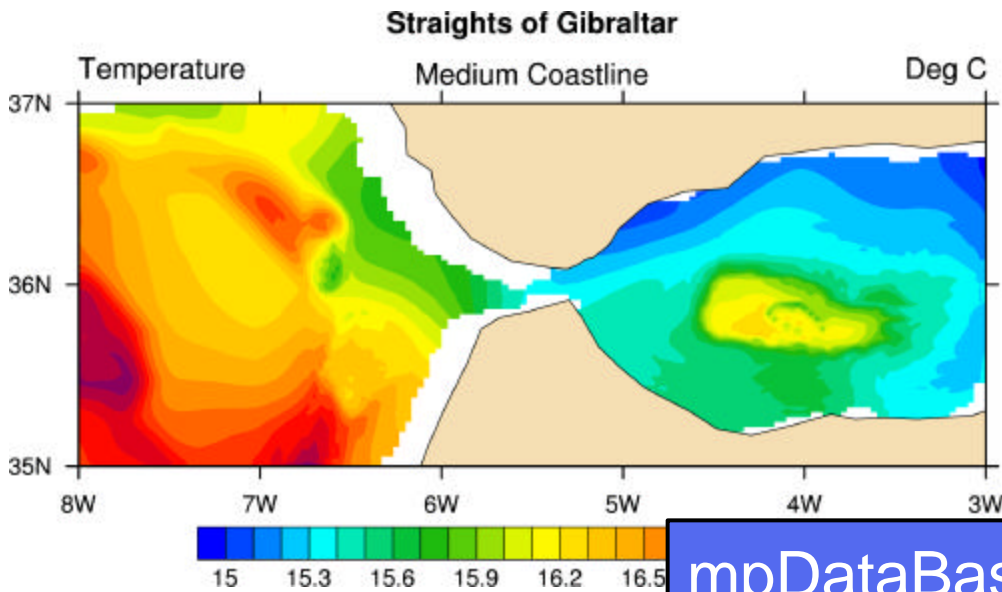lon2d   = f->TLONG
roff   = f->ROFF

roff@lon2d = lon2d
roff@lat2d = lat2d

Not appropriate for native grid projections if you want to keep them on that projection

NCAR Command Language

Straights of Gibraltar

Temperature   Default Coastline   Deg C
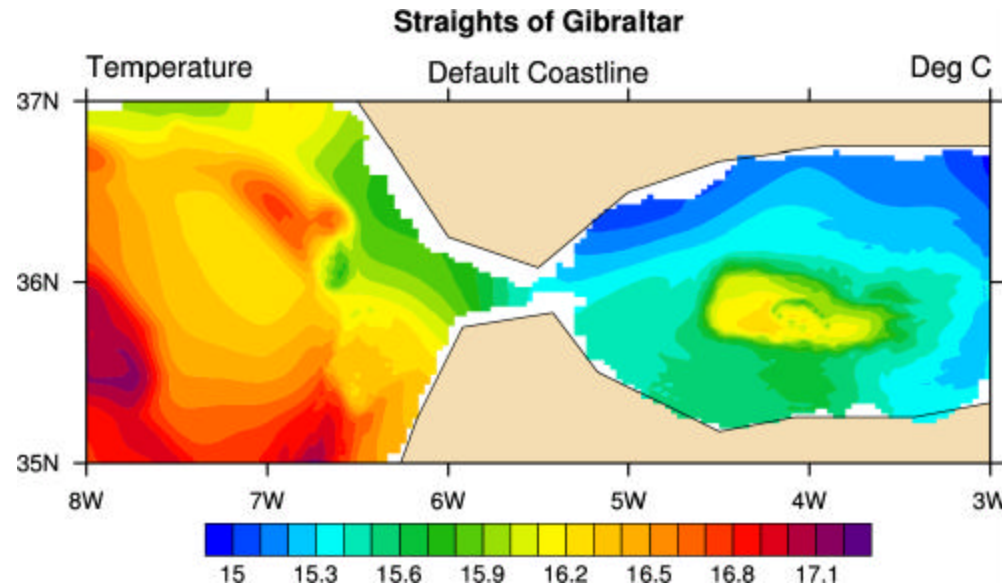
Default coast is better suited for global domains.

Straights of Gibraltar

Temperature   Medium Coastline   Deg C

Medium level coastline is best for large subregions e.g. Atlantic

mpDataBaseVersion ="Ncarg4_1"
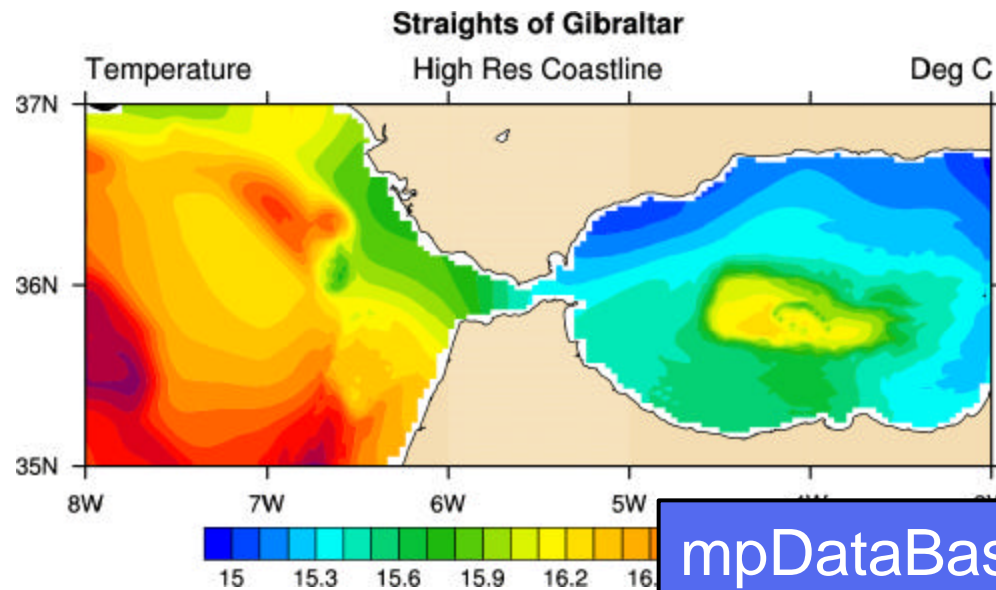
High resolution coastline is best for very small regions

mpDataBaseVersion ="highres"

• If not on NCAR system, must download RANGS-GSHHS database.

•Will slow plot draw

•Will increase size of plot

http://www.cgd.ucar.edu/csm/support/CSM_Graphics/coast.shtml

Automatic page maximization

- **res@gsnMaximize = True**
  - Resizes the plot to fill the page.
  - Will automatically choose landscape or portrait for you
  - Works only on postscript files and X11 windows

- **res@gsnPaperOrientation** = "landscape" or "portrait"
  - Can be used to require a particular orientation.
  - Must be combined with gsnMaximize.

http://www.cgd.ucar.edu/csm/support/CSM_Graphics/resize.shtml

Changing the Aspect Ratio of a Map

res@mpShapeMode **= "FreeAspect"**
res@vpWidth **= 0.8**
res@vpHeight **= 0.4**
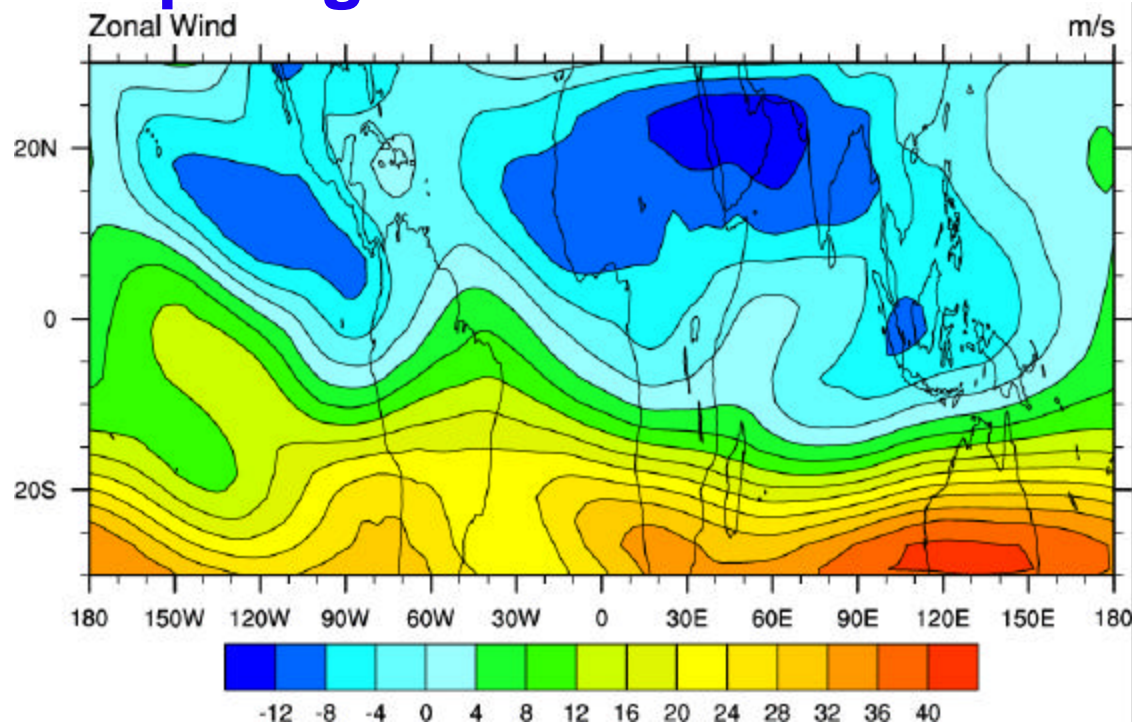
- Create a graphical array

  plot = new(3, graphic)

  | **gsn_panel** |

- Create individual plots a members of the graphical array

  A panel plot

  res   = True

  res@gsnDraw   = False

  res@gsnFrame = False

  plot(0) = gsn_xy (wks, x, y1, res)

  plot(1) = gsn_xy (wks, x, y2, res)

  plot(2) = gsn_xy (wks, x, y3, res)

- Pass the graphical array to gsn_panel

  gsn_panel (wks, plot, (/3,1/),pres)

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NCAR Command Language
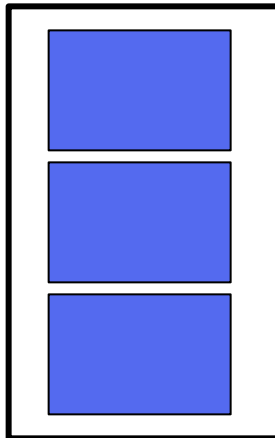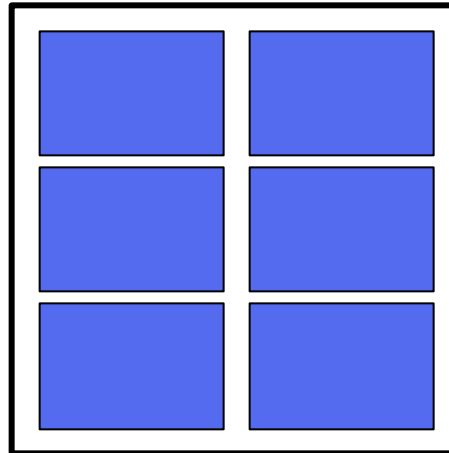
(/3,1/)   (/3,2/)   (/3,2/)
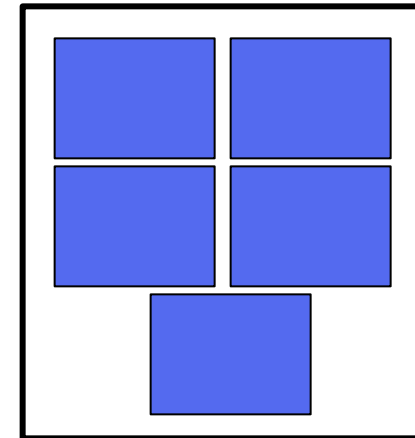
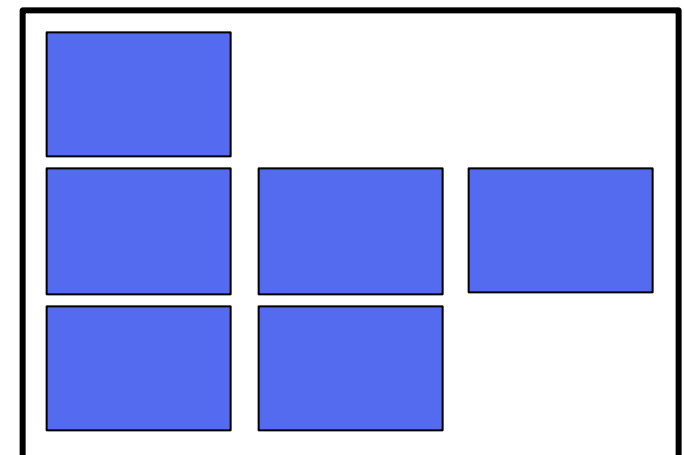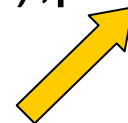pres   = True
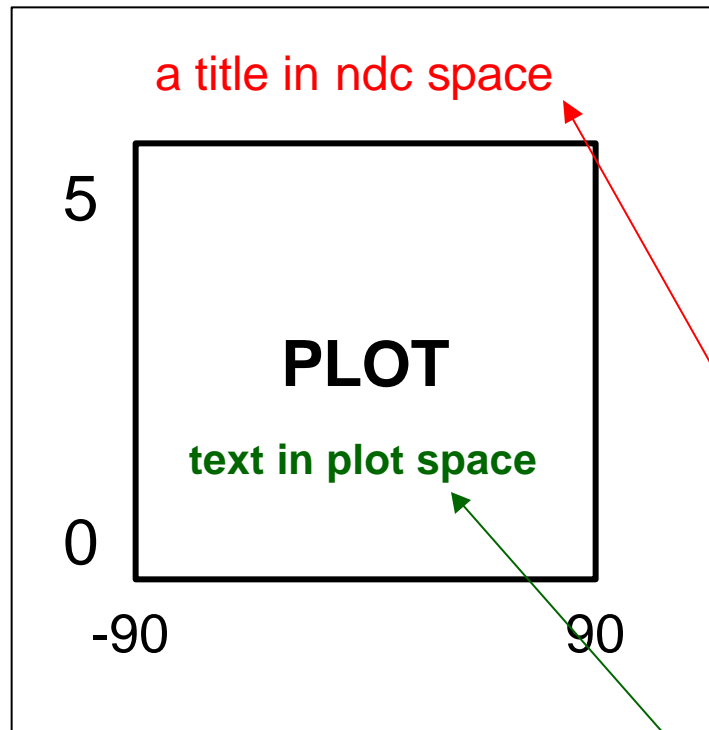
pres@gsnPanelRowSpec = True

gsn_panel(wks,plot,(/1,3,2/),pres)

Two types of coordinates

y=1.0

NDC or Page coordinates

PLOT

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0

-90   90

Plot coordinates

x=0.0,y=0.0   x=1.0
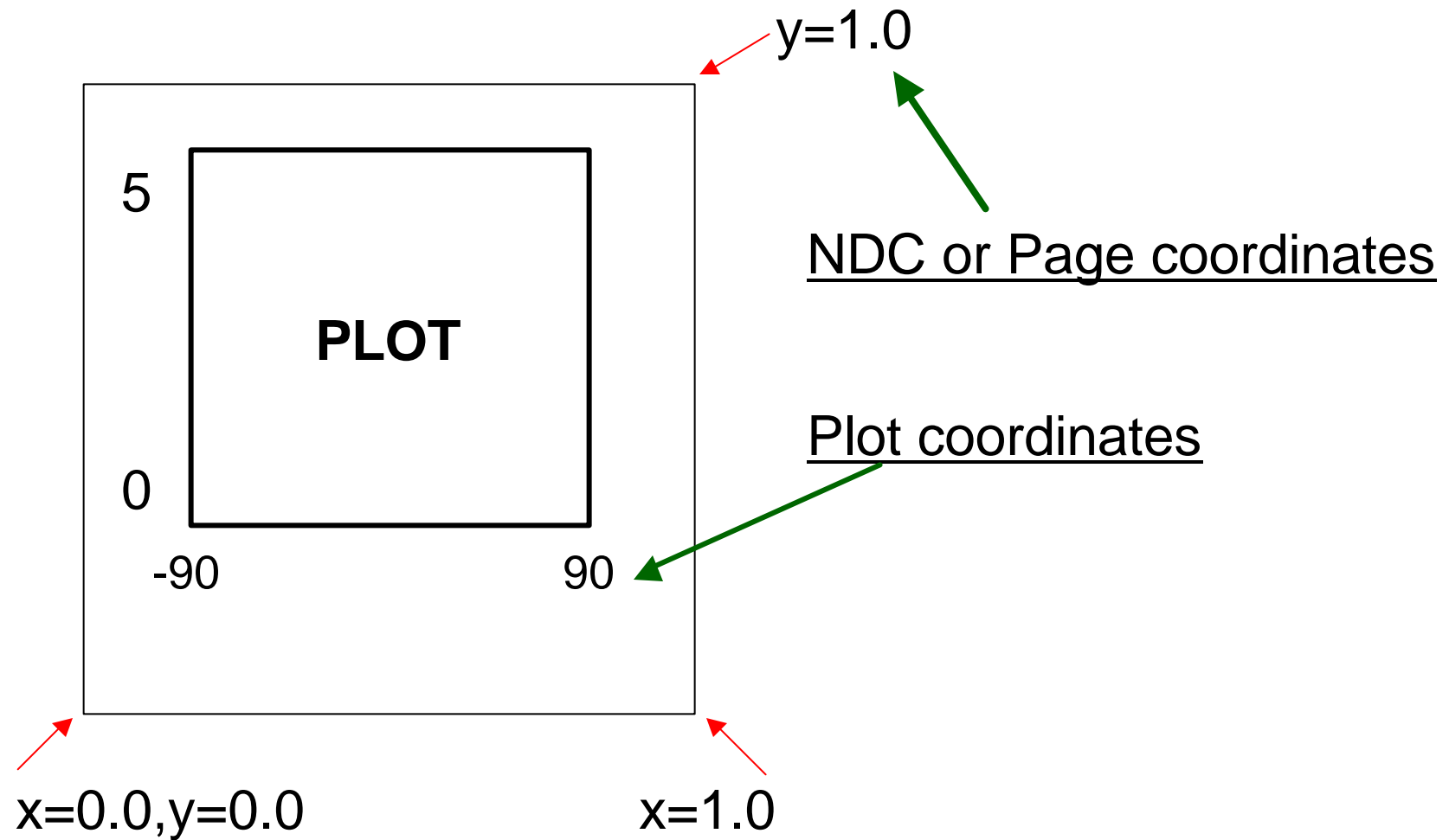
Text functions (can not be paneled)

a title in ndc space

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PLOT

text in plot space

0

-90   90

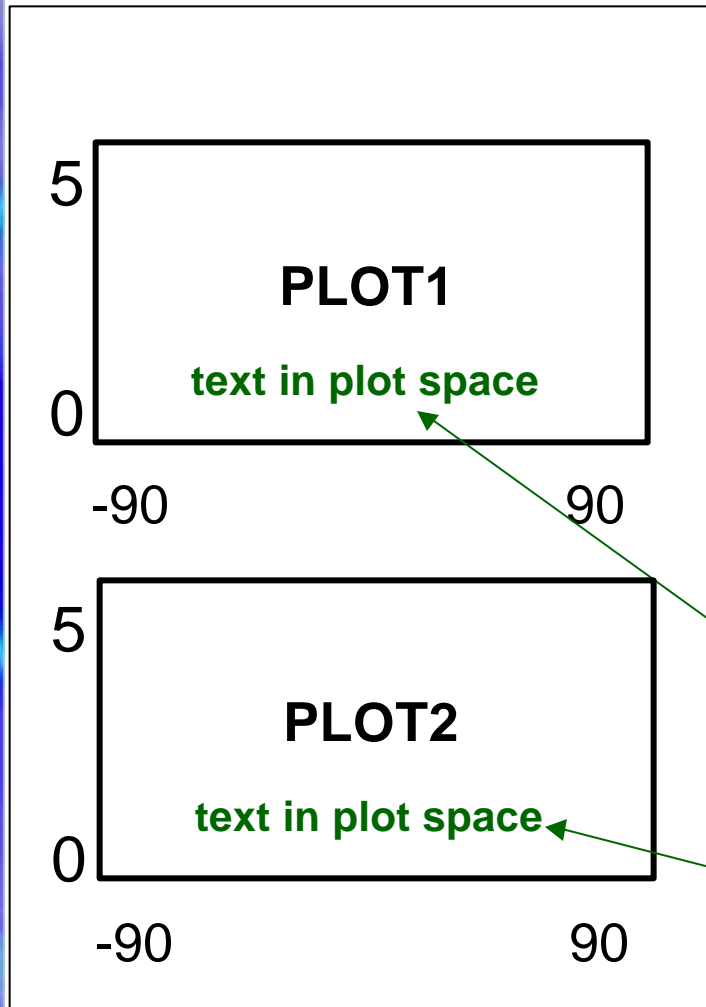title = "a title in ndc space"

x = 0.5

y = .95

txres = True

txres@txFontHeightF = 0.015

gsn_text_ndc(wks,title,x,y,txres)

text = "text in plot space"

txres@txFontHeightF = 0.012

gsn_text(wks,plot,text,0,3,txres)

gsn_add_text (can be paneled)

```
res              = True

res@gsnDraw  = False

res@gsnFrame = False

text              = "text in plot space"

; text resources

tres                = True

tres @txFontHeightF = 0.012

plot(0) = gsn_csm_contour(wks,data,res)

x1=gsn_add_text(wks,plot(0),text,0,3,tres)

plot(1) = gsn_csm_contour(wks,data,res)

x2=gsn_add_text(wks,plot(1),text,0,3,tres)

gsn_panel(wks,plot,(/2,1/),pres)
```

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PLOT1

text in plot space

0

-90   90

5

PLOT2

text in plot space

0

-90   90

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convert –density 300 –crop 0x0 foo.ps foo.gif
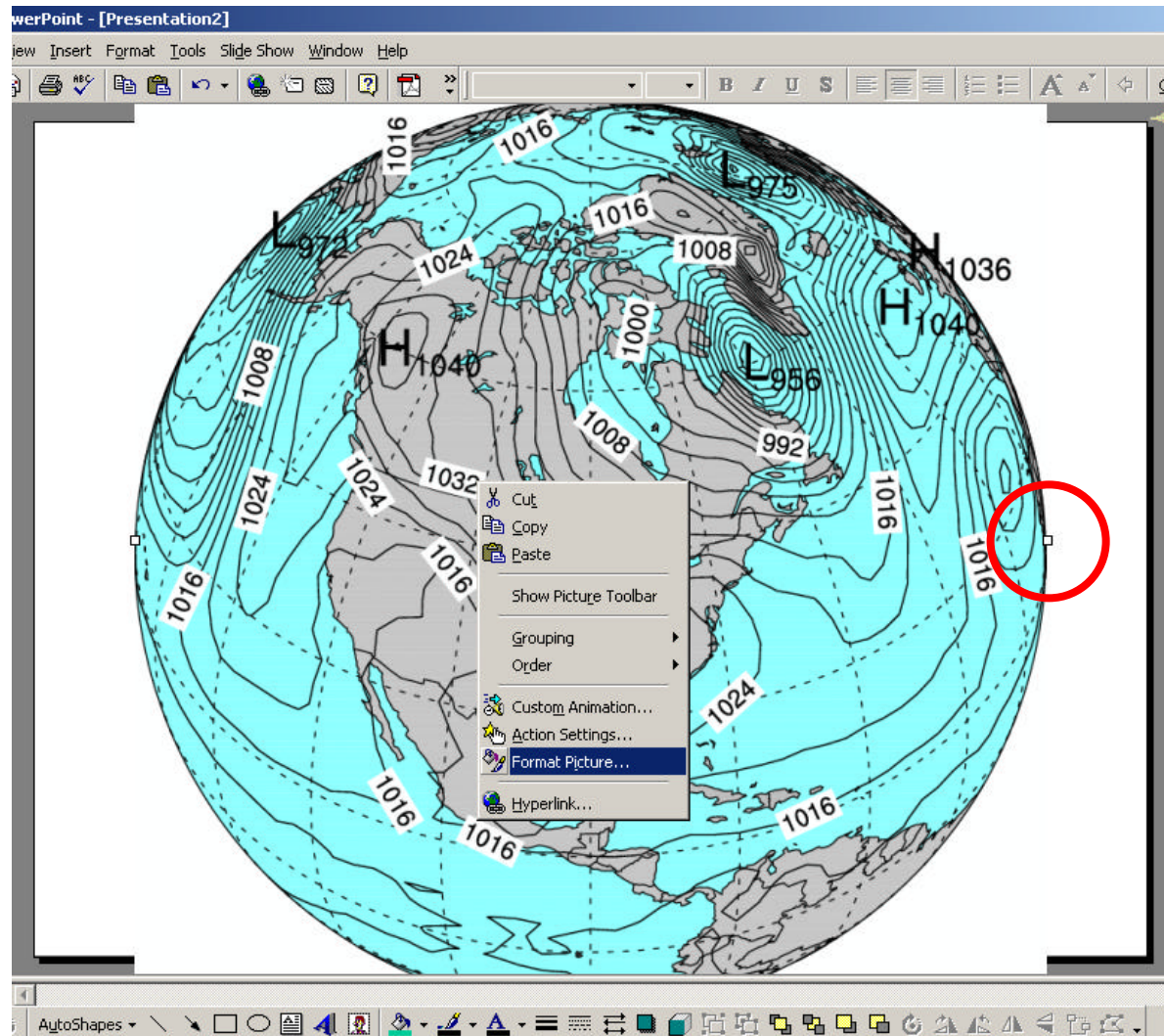
- Highlight image (single left click)

- Right click to get pull down menu

- Scroll down to "Format Picture"
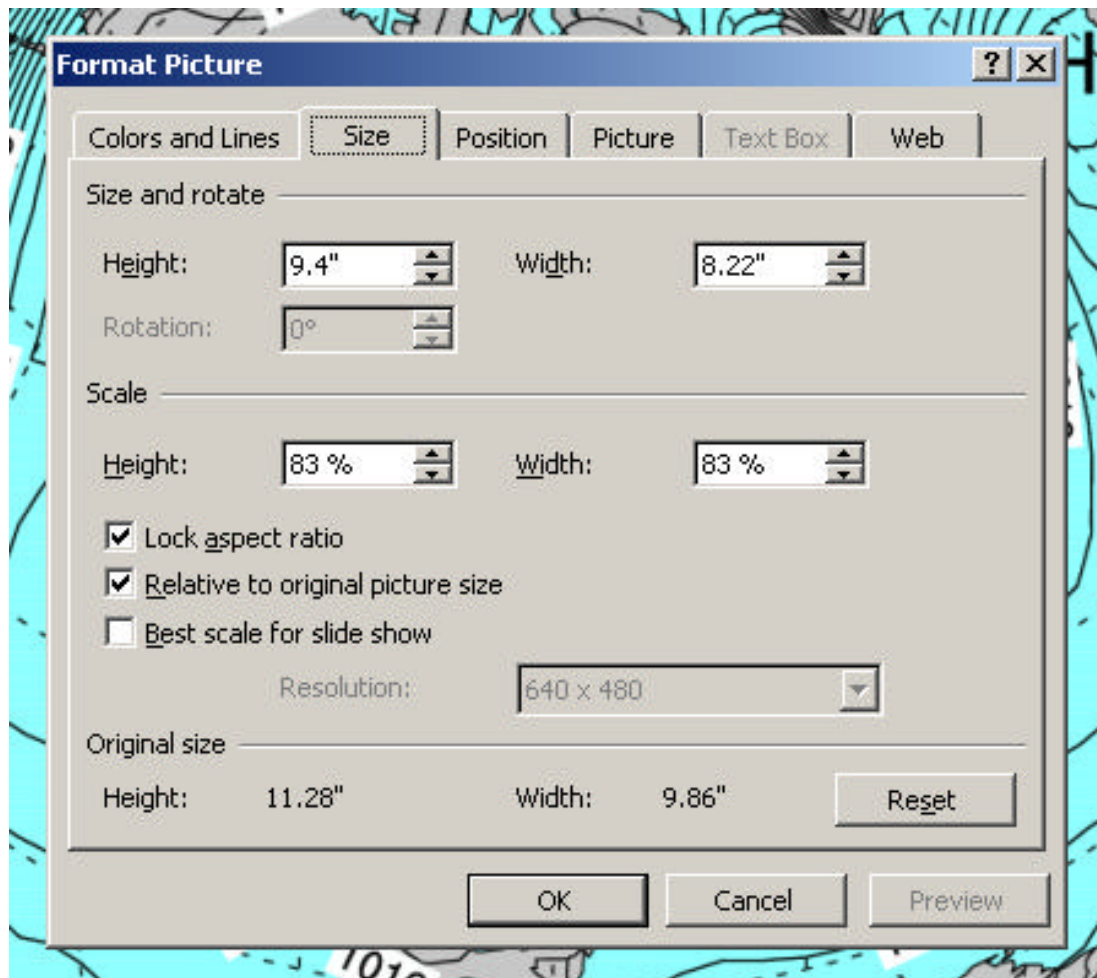
- Select the size tab

- In the Height box, adjust size accordingly

- Ensure aspect ratio is locked.

Outline

- How NCL Graphics Works
- Survey of what's possible
- A look at some techniques

Common error messages

- References

```
(0) check_for_y_lat_coord: Warning: Data
either does not contain a valid latitude
coordinate array or doesn't contain one
at all

(0) check_for_lon_coord: Warning: Data
either does not contain a valid longitude
coordinate array or doesn't contain one
at all
```

FIX: Need to change lat/lon named dimension to be one of those listed on slide 10

```
(0) is_valid_lat_ycoord: Warning: The
units attribute of the Y coordinate array
is not set to one of the allowable units
values (i.e. 'degrees_north'). Your
latitude labels may not be correct.

(0) is_valid_lon_xcoord: Warning: The
units attribute of the X coordinate array
is not set to one of the allowable units
values (i.e. 'degrees_east'). Your
longitude labels may not be correct.
```

FIX: Need to change the units attribute of the lat/lon coordinate variable to be one of those listed on slide 11.

```
(0) gsn_add_cyclic: Warning: The range of
your longitude data is not 360. You may
want to set gsnAddCyclic to False to
avoid a warning message from the Spline
function.
```

FIX: A cyclic point is added to the data in all map plots. If this is inappropriate (e.g. a regional plot), then you will want to set gsnAddCyclic to False

```
(0) warning:_NhlCreateSplineCoordApprox:
Attempt to create spline approximation
for Y axis failed: consider adjusting
trYTensionF value
warning:IrTransInitialize: error creating
spline approximation for trYCoordPoints;
defaulting to linear
```

FIX: Chances are this has occurred because of an error in the longitude coordinate variable. It is either incorrect or there is a gap in the data.

```
fatal:ContourPlotDraw: Workspace
reallocation would exceed maximum size
16777216 fatal:ContourPlotDraw: draw
error fatal:PlotManagerDraw: error in
plot draw fatal:_NhlPlotManagerDraw: Draw
error
```

FIX: The plot of your data is too large for NCL's default 16MB size. You must increase the size by setting:

```
setvalues NhlGetWorkspaceObjectId()

    "wsMaximumSize": 33554432

end setvalues
```

Outline

- How NCL Graphics Works
- Survey of what's possible
- A look at some techniques
- Common error messages

- References

NCAR Command Language

References
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Address | http://www.cgd.ucar.edu/csm/support/CSM_Graphics/index.shtml
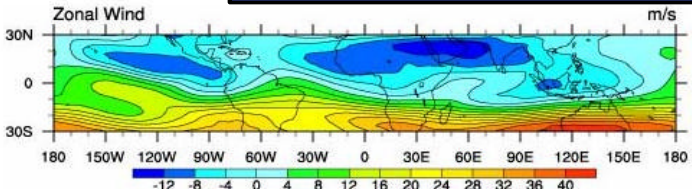
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COAMPS	Latitude vs. Time	Oceanography POP	Sea Ice
Coastlines	Layout Tricks	PaleoClimatology	Satellite Projections
Color Fill	Legends	Panel Plots	Skew-T
Contour on Contour	Line	Polar Stereographic	Slices
Contour Effects	Logo, NCAR	Polygons	Streamlines
Contours w/o maps	Maps Only	Polymarkers	Trajectories
Cylindrical Equidistant	Masking	Press/Height vs. Lat	Text NEW
EOS-DIS	MCSST	Press/Height vs. Long	Time vs. Longitude
Equations	Native Projections	Press/Height vs. Time	Time vs. Latitude
Font Heights	NOGAPS	Projections	Tropical Strip Plots
Iso_levels			Vectors

http://www.cgd.ucar.edu/csm/support/CSM_Graphics/

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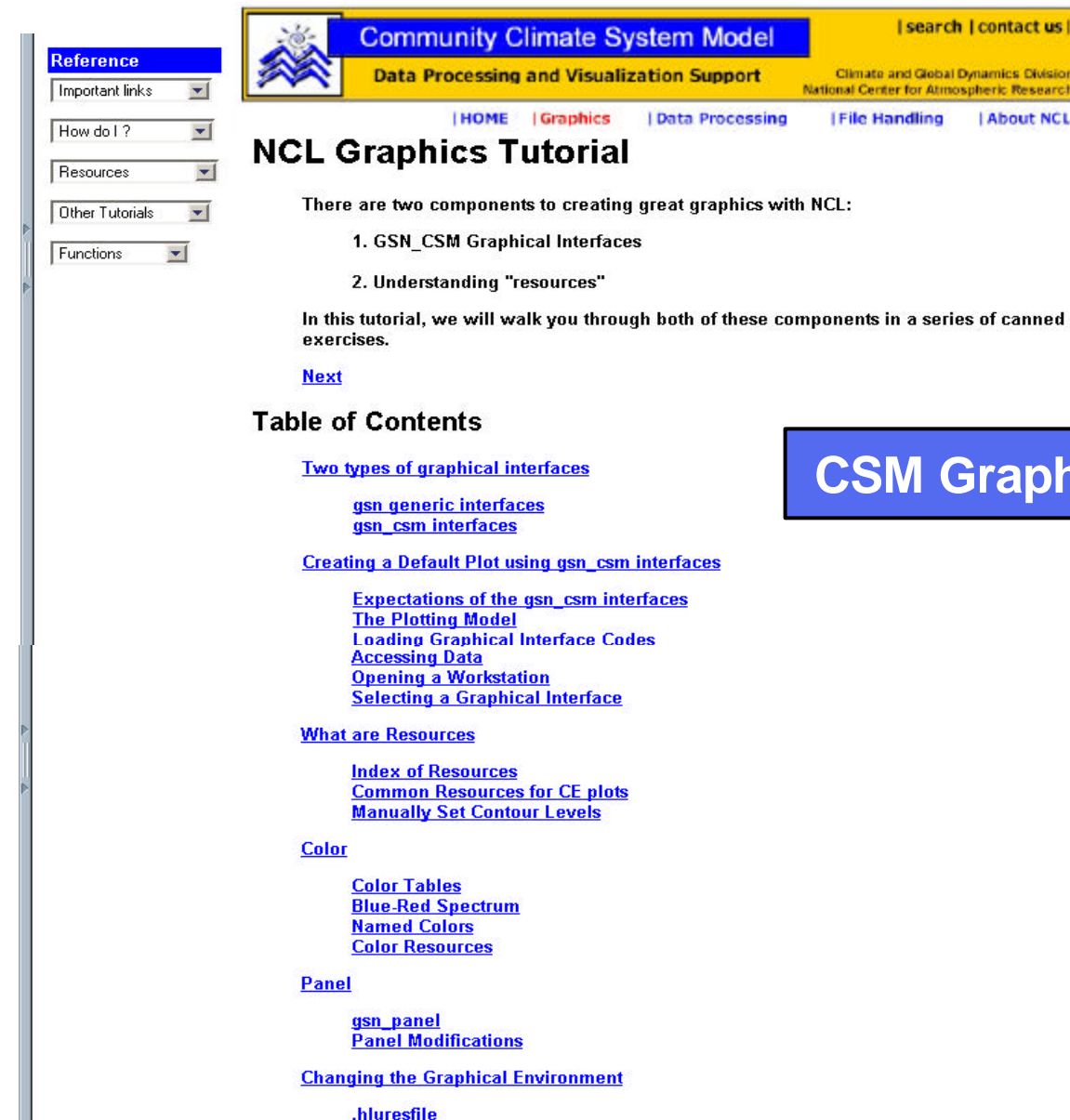
generic gsn Template Examples

http://www.cgd.ucar.edu/nclapps/gsn/

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NCL Graphics Tutorial

There are two components to creating great graphics with NCL:

1. GSN_CSM Graphical Interfaces

2. Understanding "resources"

In this tutorial, we will walk you through both of these components in a series of canned exercises.
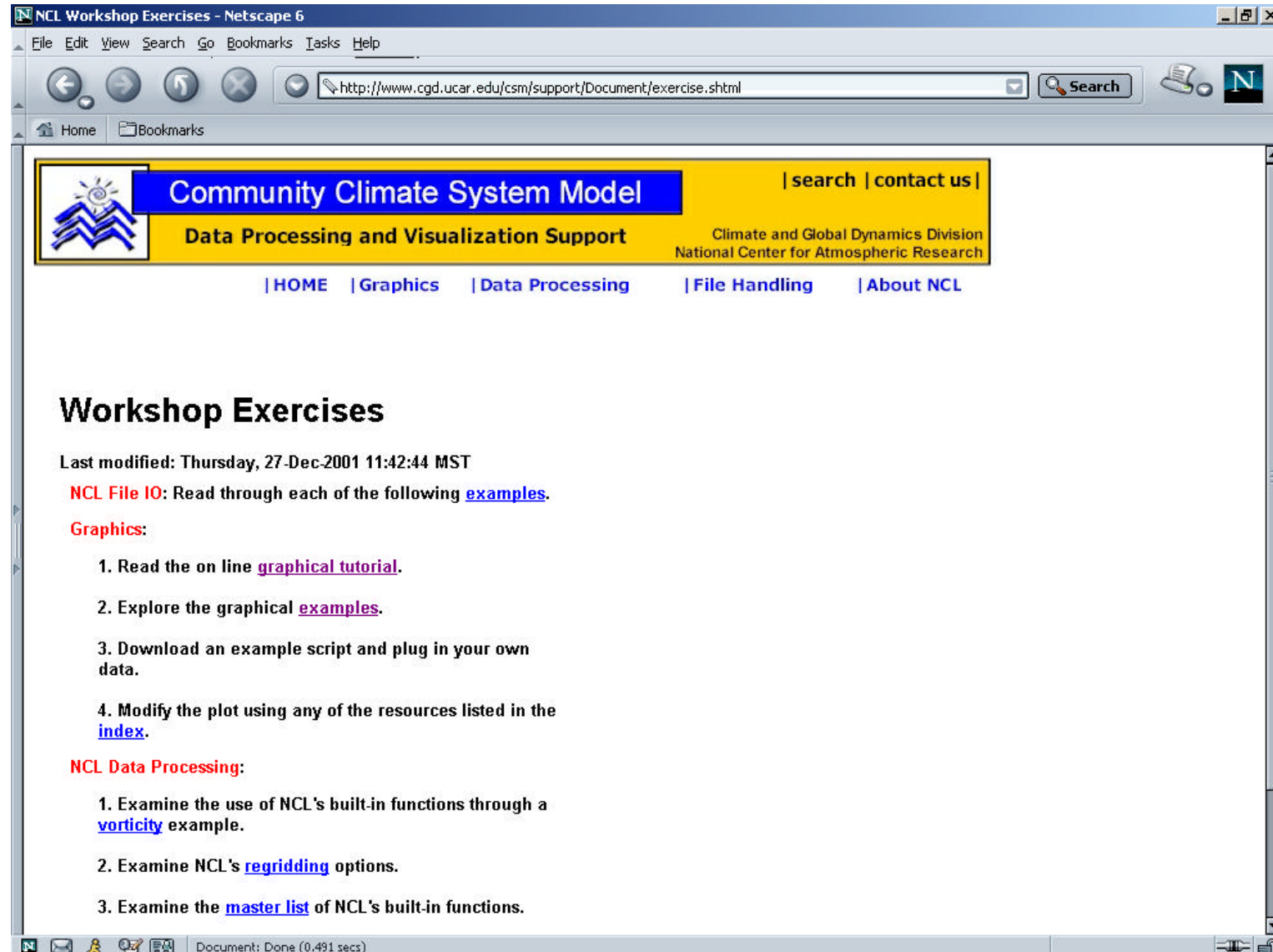
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CSM Graphics On-Line Tutorial

http://www.cgd.ucar.edu/csm/support/CSM_Graphics/Tutorial/

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